SCIENCE ABSTRACTS.

Section A.—PHYSICS.

DECEMBER 1909.

GENERAL PHYSICS.

1980. *Ballistic Kinematograph.* **C. Cranz.** (Zeitschr. Instrumentenk., Beib. 18. pp. 173–177, Sept. 15, 1909.)—With ordinary kinematograph photographs 2·5 × 1·9 cm. are taken at about the rate of 16 per sec. Even if the rate were 60 per sec., no satisfactory results could be obtained with, say, the shot from a rifle. The ballistic kinematograph described in the present paper gives a time interval of from $\frac{1}{5000}$ to $\frac{1}{3500}$ sec., so that shot photographs can be readily obtained, and from these the velocity of the shot can be found. The pendulum used makes electrical connections at different points of its swing, and these are utilised to obtain the photographs. For diagrams of apparatus and description the original paper should be consulted. A. W.

1981. *Optical Microseismograph.* **L. Fontaine.** (Annal. Chim. Phys. 17. pp. 418–436, July, 1909.)—A design is suggested whereby the necessary amplification of the earth movement is obtained by a system of reflections. The apparatus consists essentially of a vertical pendulum carrying a mirror from which a ray of light may be reflected to a moving sheet of photographic paper. Various arrangements of the details are described, the one selected giving a movement of the photographic film of 1 mm. per sec.; length of pendulum, 0·32 m.; weight of pendulum, 300 gm.; the number of trepidations per min. distinctly recorded varied from about 130 to 180. The variation of interference fringes between the pendulum mirror and a fixed mirror may also be employed for the detection of very minute tremors. C. P. B.

1982. *Optical Pressure-indicator.* **J. Kirner.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1675–1681, Oct. 9, 1909.)—An indicator is designed and used for obtaining a record of the variation of pressure in a gun-barrel during the firing of a shot. It depends on the principle of interference, and the pressure causes the compression of two lenses and the consequent spreading out of Newton's rings formed by the lenses. An image of the middle portion of the field is formed on a photographic plate by means of a slit and objective, and the image is narrowed still more by a cylindrical lens placed in front of the sensitive plate. Details of the optical and mechanical arrangements are given, and of the calculations to obtain the size of lens capable of standing the pressure. With a muzzle velocity of 640 m./sec. and a given length of barrel, the duration of high pressure is calculated at 0·0018 sec., and with a length of indicator diagram of 15 cm. the sensitive plate has to move at 110 m./sec. This is done by fixing the photographic plate on a disc which rotates 8,400 times per min. The light from an arc lamp is employed as illuminator, and a shutter is automatically opened and shut by an arrangement which ensures a single exposure. A number of diagrams are given, from one of which it appears that the pressure rises to 2,500 atmos. G. E. A.

1983. *Sensitive Micro-balances and a New Method of Weighing Minute Quantities.* **B. D. Steele** and **K. Grant.** (Roy. Soc., Proc. Ser. A. 82. pp. 580–594, Sept. 18, 1909.)—Two types of micro-balance are here described, the more sensitive one having been constructed with the idea of measuring the amount of radium emanation given off by radium bromide, and is sensitive to 4×10^{-9} gm. The second type of balance is for the absolute determination in weight up to $\frac{1}{10}$ gm. with an accuracy of 10^{-7} gm. The cases of both balances were made of $\frac{1}{8}$-in. brass, tinned inside and out. In each case there is also connected a manometer and a two-way stop-cock, so that communication can be made either with the atmosphere or with a Geryk vacuum pump. The beams of both balances were made entirely of quartz in the form of a double triangle, the more sensitive one having a mass of 0·177 gm. To the beam is fused a concave quartz mirror, and the position of equilibrium is determined by means of the lamp and telescope method. To prevent disturbances due to heating, the Nernst lamp used is placed in a metal case, and the light is passed through a hole in it and through a solution of alum. Irregularities in behaviour of the balance due to electrification are entirely obviated by placing on the floor of the balance a little uranium oxide. Before finally adjusting, the beam was boiled in *aqua regia* and washed with distilled water. The central and only knife-edge of the more sensitive balance was ground upon a quartz rod and rests on a polished plate of quartz crystal. Attached to one end of the beam is a small quartz bulb containing air sealed up at a known temperature and pressure. At the other end could be attached a quartz counterpoise of any desired shape. The effective weight of the air contained in the quartz bulb will vary with the pressure of the air inside the case. The principle of the method of measurement consists in measuring the change in pressure of the air in the balance case required to maintain equilibrium when there is a change in weight of the counterpoise. Thus a change in pressure of 1 mm. in the case was found to correspond to a variation in effective weight of $1{\cdot}8 \times 10^{-8}$ gm., and an alteration of 1° C. at 20 mm. pressure to a variation of less than 1×10^{-9} gm. The construction of the second type of balance is also described.

W. C. S. P.

1984. *Electromagnetic Method of Solving Algebraic Equations.* **A. Russell** and **J. N. Alty.** (Phil. Mag. 18. pp. 802–811, Nov., 1909. Paper read before the Physical Soc., June 25, 1909.)—Wright's device for solving equations gives approximate values of the real roots at once by simple mechanical and electrical operations. But to find imaginary roots some analytical work is first required. The electromagnetic method described in the present paper, though not so exact, gives approximate values of both real and imaginary roots direct by means of very simple apparatus. The method was suggested by a series of papers by F. Lucas (Comptes Rendus, 106, 1888). The final electrical method devised by Lucas is a practical one. A sheet of tin-foil is spread over a sheet of glass or other insulating material. If the equation is of the nth degree $(n+2)$ sources and sinks for electric current are provided, arranged on a line and equidistant. The currents in $(n+2)$ wires touching at the sources and sinks are adjusted to have certain definite values. The equipotential lines are then traced out. Theory shows that the real roots are given by the abscissæ of the nodal points lying on the axis of X, which is taken as the line joining the sources and sinks, the origin being mid-way between the two outer wires. Also, if (x_1, y_1) be the co-ordinates of a nodal point, it follows from the symmetry of the arrangement that $(x_1, -y_1)$ will be the co-ordinates of another nodal point; $x_1 \pm y_1\sqrt{-1}$ then gives a pair of conjugate roots of the given equation. The authors' method is a modification of the above, in which the horizontal field due to the earth's magnetism is used in an analogous manner to the conducting sheet of Lucas' method. The wires carrying the current pass through a slit in a horizontal drawing-board, on which a sheet of sectional paper is fastened. The wires are kept taut by means of springs, and the currents in them are read on ordinary ammeters. The neutral points are obtained by means of a small compass-needle, and the co-ordinates of these points give the required real and imaginary roots of the equation. Results can be readily obtained correct to 1 per cent. For the theory the original paper should be referred to.

A. W.

1985. *Report of the Reichsanstalt for* 1908. (Zeitschr. Instrumentenk. 29. pp. 103–118, April; 143–163, May, and pp. 179–196, June, 1909. Engineering, 88. pp. 750–751, Dec. 3, and pp. 835–837, Dec. 17, 1909.)—Abstracts of all of the published papers of physical interest have already appeared. Valentiner finds an increase in the value of $\theta/(T_1^4 - T_0^4)$ of 0·5 per cent. per 1° C. increase of temperature (θ) of a bolometer between 16° and 24° which is used to measure the radiation from a black body at $T_1(100°)$. T_0 is the temperature of the screen between black body and bolometer. The moisture of the air between black body and bolometer has much less effect upon the radiation. The effect of the size of the black body is being dealt with. Brickwork piers of three and four years of age expanded on the average 18 μ per 1 m. during the year. With pure white chalk and gypsum the expansion was half this amount, and with pure cement more than double.

F. R.

1986. *Vibrations of a Thin-walled Cylinder.* **E. L. Nikolai.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 5. pp. 214–227 (Phys. Part), 1909.)—A mathematical paper, giving the following results. If, for a cylinder filled with liquid, the frequency of vibration, corresponding with the $2n$ nodal points, is N_n, and for the empty cylinder the frequency of the same vibrations is N_n^0, then $N_n^0/N_n = \sqrt{[1 + n\rho a/\gamma\epsilon(n^2+1)]}$, where a is the radius of the transverse section of the cylinder, ϵ the thickness of its walls, and γ and ρ the densities of the cylinder walls and liquid respectively. The same formula applies to the case where the cylinder is empty and is immersed in a limitless liquid. When the cylinder is filled with liquid and is immersed in the limitless liquid, the frequency of vibration, N_n, satisfies the relation—

$$N_n^0/N_n = \sqrt{[1 + 2n\rho a/\gamma\epsilon(n^2+1)]}.$$

Thus, when a cylinder is either filled with liquid or immersed in liquid, its rapidity of vibration is lowered, the extent of the lowering of the frequency increasing with the density of the liquid. Further, the greater the number of nodal points, the less will be the diminution of the frequency by filling the cylinder with liquid or immersing it in liquid. By filling the cylinder with liquid or immersing the empty cylinder in liquid, the same lowering of the frequency is produced. The lowering is very great when the cylinder filled with liquid is immersed in liquid. The expressions given above yield results identical with those obtained experimentally for ether, alcohol, water, glycerol, and solutions of sodium and calcium chlorides, and copper and magnesium sulphates of varying concentrations. T. H. P.

1987. *Internal Energy of Rupert's Drops.* **K. Lerp.** (Phys. Zeitschr. 10. pp. 639–643, Sept. 15, 1909. Physikal. Inst., Göttingen.)—Assuming a Rupert's drop to be spherical and the tension identical on all sides, the author deduces the value 4·38 gm.-cals as a higher limiting value for the quantity of heat stored in the drop per cm.^{3}. By measuring the bending moment required to break off the point of the drop when the latter is supported on an edge, the value of χ, the coefficient of resistance to bending is found to be 40·8–77·6, the latter value approaching that for hardened steel (80). There is doubtless a connection between the extraordinary hardness of the glass drops and the internal tensions or the energy stored up. Calorimetric measurements give the mean value 0·067 (0·060–0·073) gm.-cal per gm. of the drop for the heat evolved on breaking the drop. The specific gravity of the drops, s_1, is 2·5111 (2·5104–2·5118), that of the glass before fusion, s_2, being 2·5261 (2·5251–2·5274); the expansion $a = (s_2 - s_1)/s_1$ has the value 0·006013–0·006070. The radial pressure necessary to produce stresses equivalent to those existing in the drops is 8819·5 atmos. T. H. P.

1988. *Molecular and Frictional Flow of Gases in Tubes.* **W. J. Fisher.** (Phys. Rev. 29. pp. 325–327, Sept., 1909.)—The author points out that the formula of Knudsen [Abstract No. 871 (1909)] becomes identical with that put forward by O. E. Meyer when the pressures are large. When the pressures are low a new factor expressed by $(1 + c_1 p)/(1 + c_2 p)$ comes into play; but the author thinks that the need of this factor is due to faulty experiment, since at the low pressures used by Knudsen the gas must contain mercury vapour. Knudsen's observations, then, at low pressures relate not to the molecular flow of gases, but to the flow of varying mixtures of gases and mercury vapour. Were this vapour disturbance eliminated it is not at all improbable that the results would be very well expressed by the long-known formula of O. E. Meyer. A. F.

1989. *Incorrect Applications of Hydraulic Laws.* **D. Bánki.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1490–1496, Sept. 11, 1909.)—The author considers certain cases in which the fundamental laws of hydraulics are incorrectly applied, as, for example, the application of the Borda-Carnot law to the problem of the "Labyrinthdichtung," the production of the stream lines near valves, and the calculation of the loss of energy due to a sudden change in direction by assuming that there is a loss of one of the components of the velocity. His calculations show that the deviation of the stream lines at an edge is fixed, and he shows by experiment that Hermann's theory cannot be applied. His experiments are extended to the case of a curved tube, and he shows that such a swelling as is calculated on the assumption of the concentration of the stream lines does not in reality take place. An apparatus is described which can be used for the experimental observation of such cases; it consists essentially of a very thin indiarubber tube for the conduction of the water stream and can be exposed to any desired external pressure. W. C. S. P.

1990. *Method for Aerodynamic Experiments.* **A. Rateau.** (Comptes Rendus, 148. pp. 1662–1664, June 21, 1909.)—Plane or curved surfaces are exposed to a uniform current of air issuing from a converging orifice. This is better than the "tunnel" arrangement, which does not admit of the free bending of the lateral air-stream lines. Experiments made with a thin sheet-iron plate 30 × 50 cm. show that as the inclination of the plate to the horizon increases, the centre of pressure recedes from the forward edge towards the centre of the plate, which it reaches when the air impinges normally upon the plate. A new fact elicited is that this shifting of the centre of pressure is not continuous. At an angle of 29° to the horizon an unstable condition sets in, under which the centre of pressure is liable to a sudden shifting. With the centre of pressure at 0·43 of the whole width, reckoned from the advancing edge, the inclination may be either 28° or 40°. At the greater angles the shifting of the centre of pressure is about three times less rapid than at the smaller angles. The diagram giving angles and centres of pressure consists of two separate approximately straight lines. E. E. F.

1991. *Air Pressure on a Surface.* **A. Rateau.** (Comptes Rendus, 149. pp. 260–263, July 26, 1909.)—By means of the air-blast apparatus [see preceding Abstract] measurements of the horizontal and vertical pressure were made on a cylindrical surface 15 × 50 cm., whose tangent at the edge made an angle of 10° with the chord. The sustentation is zero for a negative angle of the chord to the horizon of 4° 30′. From that point up to a positive angle of 15° the sustentation increases linearly. Between 25° and 35° an unstable condition sets in, and after 35° another linear change sets in. The author tested various other surfaces, flat or concave, and some of them thicker in the centre than at the edges. Plotting the inclinations as abscissæ, and as ordinates the ratios of vertical to horizontal thrust, the most abrupt curve is obtained with a plane surface, which shows a maximum ratio 14 at an inclination of 1° 30′. The highest ratio, 21, is shown by a curved thin surface, and the flattest curve by a thick surface whose two tangents at the edge make angles of 16° and 24° respectively with the chord. A lenticular section (as in birds' wings) has distinct advantages. E. E. F.

1992. *Flapping Flight.* **L. Thouveny.** (Comptes Rendus, 148. pp. 1661–1662, June 21, 1909.)—The propulsive and sustaining qualities of a wing are opposed to each other, and must be mutually sacrificed. The propulsive qualities are: Concavity and elasticity (both of the whole wing and of the whip end) and length of the whip. The sustaining qualities are those of an aeroplane—large surface, slight concavity, predominance of the arm over the whip. In birds which do not use the wind much the propulsive qualities are more accentuated, except that the wings are stiff in order to make a great effort possible. Instantaneous starting is assured by excessive curvature, as in the case of the sparrow. In the pigeon there is a balance between the two sets of qualities. The swallow and frigate utilise the wind by means of their wide and flat whips, which, however, are curved on lowering. [See Abstract No 606 (1909).] E. E. F.

1993. *Flying Animals and Flying Machines.* **A. Mallock.** (Nature, 81. pp. 247–248, Aug. 26, 1909.)—In order that the wings may support the body their movement must generate a downward current of air of which the momentum per unit of time is equivalent to the downward momentum which the body and wings would acquire in the same time under the influence of gravity. If the animal can only deliver a certain amount of power per unit weight of body there is an absolute limit to the weight of an animal which can sustain itself stationary in the air. The author illustrates this principle by an animal climbing a rope ladder attached to a parachute. The centre of gravity of the system is maintained at a constant level if the animal climbs with sufficient speed. If 80 ft. per min. is the limiting velocity of climbing, and if the area of the parachute which will drop at the appropriate speed when the total weight of parachute and load is 1 lb. is 100 sq. ft. and the parachute weighs ¼ lb., it appears that no animal could maintain itself stationary in the air by means of a parachute weighing more than 10¼ lbs., and the supporting surface would have to be more than 1,600 sq. ft. E. E. F.

1994. *Gravitation Constant.* **V. Crémieu.** (Comptes Rendus, 149. pp. 700–702, Oct. 26, 1909.)—This is a continuation of the author's researches on changes in the vertical affecting determinations of the gravitation constant by the torsion balance [see Abstract No. 1157 (1909)]. Special precautions taken to prevent flexure of the fibre near its extremities have reduced but not removed the error. The author shows that to obtain good results only such observations may be used as are made when the vertical has the same position. Those times he obtains from a second balance used as a microseismograph. A. D. R.

1995. *Meteorology of Samoa,* 1902–1906. II. *Rainfall.* **O. Tetens.** (Monthly Weather Rev., Washington, 37. pp. 200–207, May, 1909.)—The self-recording rain-gauge of Hellmann, constructed by Fuess, has a receiving area of 200 cm.^{2}. It is surrounded by palms, but at a distance, and the palms do not appear to affect the catch of the gauge. The observations comprise 4 wet and 4 dry seasons; the rainy season is not very pronounced. The report speaks of "characters" of seasons, the character of a season with regard to that of the preceding and the following season being expressed by a figure which is obtained "by taking the difference of logarithms for the season in question and for the geometric mean of the contiguous seasons." The rainfall is large, and monthly, daily, hourly rainfalls are considered, the term "grades of rain" being used. The values for successive whole grades are 10^0, $10^{\frac{1}{2}}$, 10^1, $10^{\frac{3}{2}}$, 10^2, &c., or 1, 3·16, 10, 31·6, 100. . . . As the rainfall is considerable, rainfalls of less than 0·1 mm. might be classed as grade 0; to facilitate comparisons, however, only rainfalls of 0·05 mm. and less are graded as 0, and those of 0·1 mm. as 1. H. B.

1996. *Barometric Gradient and Wind Velocity.* **T. Okada.** (Mathematico-Physical Soc., Tōkyō, Proc. 5. 7. pp. 119–126, July, 1909.)—The author gives a simple graphic method for determining the value and direction of the barometric gradient from barometer readings, reduced to sea-level, for three neighbouring stations. He then gives a comparison of the observed gradients and wind velocities for Chôsi for the years 1906, 1907. The results may be expressed by a linear formula $G = a + bw$. If G be expressed in mm. per 111 km., w in m./sec., the values of a and b are as follows: (1) Winds from NE. quadrant $a = 0·889$, $b = 0·117$; (2) NW. quadrant $a = 0·201$, $b = 0·114$; (3) SW. quadrant $a = -0·885$, $b = 0·142$; (4) SE. quadrant $a = 0·168$, $b = 0·115$. The variation in the velocity corresponding with a given gradient does not exceed 10 per cent. on account of the seasonal variations of temperature, pressure, and humidity. At Chôsi, winds in groups (1) and (4) come from the

Pacific, those of group (2) over the Kantô plain, and those of group (3) over the mountainous Bôsô peninsula. For a given gradient winds of group (3) are weaker than those from other directions by 20 per cent. R. G. K. L.

1997. *Barometric Pressure near Lake Tchad.* **Tilho.** (Comptes Rendus, 149. pp. 646–648, Oct. 18, 1909.)—The altitude of Lake Tchad is determined to be 247 m. from an extended series of boiling-point observations made during a journey from Cotonou (Dahomey) to Lake Tchad. Observations were taken both on the outward and on the return journey. Using this value, the barometric readings obtained at Lake Tchad from Nov., 1907, to June, 1908, have been reduced to sea-level. The monthly means, thus reduced, range from 749·4 mm. for April to 757·9 mm. for Dec. The mean value for the whole period, 754·1 mm., is lower than the corresponding values obtained on the one hand at stations in French West African possessions, and on the other in the Egyptian Soudan. The next lowest mean is 755·1 mm. at Mongalla in the Soudan. The observations thus indicate the existence of a well-marked low-pressure system over the centre of the North African continent. R. G. K. L.

1998. *Summer Temperature in Different Parts of Europe.* **H. H. Hildebrandsson.** (Comptes Rendus, 149. pp. 703–705, Oct. 26, 1909.)—In continuation of an investigation of the connection of meteorological events in different parts of the world [Abstract No. 1182 (1909)] it is found that the summer temperature of Scandinavia and the Baltic region extending as far as Hamburg and Hanover is controlled by the temperature conditions of the Iceland Sea during the previous winter : a cold winter at Thorshavn (Faroë) is followed by a cool summer in the North of Europe. As it has been found that low temperature in the Iceland region in winter is associated with low temperatures simultaneously in Scandinavia, we may infer that a cold winter is generally followed by a cool summer in that region. The west coast stations of Norway are found to be an exception ; their summer temperature is similar to that prevailing *simultaneously* at Thorshavn. The opposition between the divergences from mean temperature found in winter between Northern Europe and Siberia is found to persist in summer, and thus a cold winter at Thorshavn is followed by a warm summer at Barnaul (Siberia). A similar opposition is found between the summer temperature of Lyons (Central France) and the temperature of the previous winter at Thorshavn. The records for Marseilles, Montpellier, Madrid, and San Fernando show similar results. Greenwich, Archangel, and Moscow show variable results ; they sometimes fall in with the North European system, at others they agree with Siberia and Southern Europe. The results afford an indication of the direction in which we may look for successful seasonal forecasts. R. G. K. L.

1999. *Observations in Different Layers of the Atmosphere at Sea.* **M. M. Rykačev.** (Acad. Sci. St. Pétersbourg, Bull. 11. pp. 745–764, June 15, 1909.)—The author gives the results of measurements of temperature and absolute moisture of the atmosphere at different heights made during a voyage from St. Petersburg to Odessa, May 9–30, 1908. In the Bay of Biscay, measurements were made throughout the day at altitudes varying by 100 m. up to 1,800 m. It was found that, for all altitudes beginning with 100 m., the max. temperature occurs between 9.30 and 10.30 a.m., and the minimum between noon and 1 p.m. Only at the lowest altitude—6 m. above the sea—was the temperature a maximum at a later hour than that given above. For all heights from 6 to

1,800 m., with the exception of 800 m., the absolute humidity of the air exhibited a minimum between noon and 2 p.m. Above 800 m., the absolute humidity increases only in the evening, at 1,100 m., the maximum occurring at 10 p.m. At these great altitudes, the increase in humidity may be explained by the presence of clouds. The results of these measurements and of others made at other points during the voyage are given in the form of tables and curves; the instruments employed are described elsewhere (Ibid. 10. pp. 665–686, June 1, 1909.) T. H. P.

2000. *Oscillation of the Sea at Marseille, June* 15, 1909. **L. Fabry.** (Comptes Rendus, 149. pp. 824–825, July 26, 1909.)—About 8.40 a.m. the sea began to oscillate in the port of Marseille, falling and rising by about 30 or 40 cm. (measurements were not taken) in a quarter of an hour; this continued till noon. The barometer commenced to rise at 9.10; it rose by 2 mm. in 10 min., remained stationary for an hour, and fell slowly again. The author suggests that a barometric high developed in the Mediterranean, advanced towards Marseille, and caused the oscillations of the sea-water. H. B.

2001. *Variation with Altitude of Temperature and Humidity in the Free Atmosphere and on Mountains.* **J. Schubert.** (Meteorolog. Zeitschr. 26. pp. 390–396, Sept., 1909. Deutsch. Phys. Gesell., Verh. 11. 19. pp. 406–414, Oct. 15, 1909.)—Observations on mountains have shown that the temperature of the dew-point decreases, on the average, by 0·5° C. per 100 m. The average rate of decrease of temperature is found to be 0·58° C. per 100 m. The results of observations in the free atmosphere made at Berlin and Lindenberg during the years 1903–1906 give the following values for the average rate of decrease of temperature and dew-point per 100 m.: 0–1 km. temp. 0·51°, dew-point 0·55°; 1–2 km. temp. 0·42°, dew-point 0·60°; 2–3 km. temp. 0·40°, dew-point 0·42°. For unsaturated air rising freely and subject to adiabatic expansion the corresponding coefficients are: for temperature 0·99°, and for dew-point 0·17°. The temperature on mountain-tops is found to be lower than the value prevailing simultaneously at the same level in the free atmosphere in the immediate neighbourhood, whereas the dew-point is higher at the same level (from kite ascents). Using the values given above for the temperature and dew-point gradients, a simple calculation shows that the average conditions on a mountain 1,000 m. high may be expressed by assuming that the air there has come from a point in the free atmosphere 870 m. above the zero level, and that it has expanded adiabatically during its ascent. For a mountain of 2,000 or 3,000 m. the corresponding levels in the free atmosphere are 1,640 and 2,200 m. respectively. R. G. K. L.

2002. *Current-meter Observations in Loch Ness.* **E. M. Wedderburn** and **W. Watson.** (Roy. Soc. Edinburgh, Proc. 29. pp. 619–647, 1908–1909.)—The selection of Loch Ness, chosen for its length and uniformity of basin, did not prove advantageous, because high waves rendered the work dangerous, and the currents were less defined and less regular than in the smaller basin of Loch Garry [compare Abstracts Nos. 567 (1908) and 1186 (1909)]. The observations were taken by the authors and W. Macdonald with the aid of an Ekman current meter, which is described. The momentary direction of the current is indicated by noting in which division of a compass box a ball is found, which had been dropped into the cup of the compass needle at the 33rd revolution of the propeller. The current directions changed rapidly, and the observations were very complicated. General conclusions are not safe, therefore, but the following may be accepted: When the lake, which has a mean depth of 450 ft. and a length of 22·5 miles, is of uniform temperature, the direct current produced by wind is felt to considerable depths; the return current is also felt in the deepest part of the lake. When stratification and temperature discontinuity have appeared the return current is nearly always found to be above the discontinuity layer, although there are indications of secondary currents, of the same direction as on the surface, below the discontinuity. Changes in wind force and direction are felt to considerable depths; when the wind has been blowing for twelve hours, however, the surface current is restricted to a narrower zone, and the return current asserts itself. When a calm follows a strong wind the isotherms tend to assume a horizontal position, and there is consequently in the upper layers a current in a direction opposite to that in which the wind had been blowing. The return current may be close to the surface towards the windward end of the lake; at the lee end it is found in deeper water. Cross-currents are frequent and form part of the circulation of the lake. H. B.

2003. *Movements of Upper Layers of Solar Atmosphere.* **H. Deslandres.** (Comptes Rendus, 149. pp. 179–184, July 19, 1909.)—By employing a spectroheliograph of increased power the author has been able to obtain photographs of the various layers in the solar atmosphere with great purity. It is found that the K_2 region of calcium radiation is about five times more brilliant than that giving K_3 [see Abstracts Nos. 1761 (1908), 1190 and 1867 (1909)]. Photographs taken with the "spectrograph of velocities" show that the various layers are in more or less continuous agitation, the motion often assuming the character of a rotating cyclone with axis parallel to the solar surface. Details are given of some observations of the radial velocities of the filaments during a period of comparative quietude. The velocity was generally between 200 and 2,500 m. per sec. away from the sun. The vapour after leaving the region of the filament descends on either side. A study of such plates throughout an extended period provides considerable material for discussing the general movements of the solar atmospheres. C. P. B.

2004. *Movements of Solar Atmosphere.* **H. Deslandres.** (Comptes Rendus, 149. pp. 493–499, Sept. 13, 1909.)—Discussion of a series of exposures with the "spectroheliograph of velocities" made across the region of a facula, showing the distribution of radial velocities. An example of these is very strikingly shown by a diagram giving the ascending and descending currents over and about a flocculus on June 4, 1909. This most definitely indicates that the faculic vapour is all descending, while the surrounding material is ascending. Further, the velocity of descent of the central mass is much greater than the general velocity of the rising vapours outside. C. P. B.

2005. *Water-vapour in Sun-spots.* **W. M. Mitchell.** (Astrophys. Journ. 30. pp. 44–47, July, 1909.)—Recent observations have shown that many of the characteristic features of the sun-spot spectrum appear to be due to the absorption of various oxides and hydrides existing as vapours in the spot regions. As most of these are regarded as low-temperature products, it is further supposed that water-vapour may also exist on account of the reduced temperature. Unfortunately many of the recorded observations in the region 5,860–6,000 are widely discordant so far as their identification with water-vapour lines is concerned, and it is possible that they may really be faint solar lines of other elements so close to the water-vapour positions as to be mistaken for them unless very great dispersion is employed. Determinations made with a powerful spectroscope at Haverford [see Abstract No. 2008 (1909)] indicate that the supposed widening of the water-vapour lines in the spot-spectrum band may be a subjective effect caused by the dark umbral background. Hale has noted that the water-vapour lines show no evidences of circular polarisation in the sun-spot spectrum, suggesting that it is probable that they are unaffected by sun-spot absorption. From this it would appear that up to the present we have no definite evidence of the presence of water-vapour in sun-spots. C. P. B.

2006. *Sun-spot Spectra.* **W. S. Adams.** (Astrophys. Journ. 30. pp. 86–126, Sept., 1909.)—Details of the solar spectroscopic work at Mount Wilson, Pasadena, have been noted previously [Abstracts Nos. 490, 2001 (1906), 804 (1907), 207 (1908)]. The present paper summarises the work done during the three past years, dealing mainly with the identification of unknown lines, and estimation of intensities. Altogether some 11,000 lines have been measured, and details of these will be given later. In this summary the strengthened and weakened lines in sun-spot spectra are discussed with respect to each of the elements represented, viz., Ca, Cr, Co, H, Fe, Mg, Mn, Ni, Sc, Si, Na, Ti, V. A remarkable feature is noted in that out of a total of 144 metallic enhanced lines, 130 are distinctly weakened in the spot spectrum. This is in accord with the fact that the hydrogen lines are weakened in spot spectra, and a hydrogen atmosphere is one of the conditions which specially brighten the enhanced lines. As regards the banded structure so characteristic of several parts of the spot spectrum, it is estimated that out of 8,100 lines between λ4000 and λ7000, about 6,300, or 78 per cent., may be accounted for as represented by the fluting spectra of titanium, oxide, calcium hydride, and magnesium hydride. For the lines showing Zeeman-effect a complete list is given of all the lines which have been measured as double or triple. The discussion of the various elements whose lines are strengthened or weakened in the spot spectrum indicates that the changes observed may be best accounted for on the basis of a reduced temperature in spots. C. P. B.

2007. *Monochromatic Photographs of Sun.* **H. Deslandres** and **L. d'Azambuja.** (Comptes Rendus, 149. pp. 521–527, Sept. 20, 1909.)—Examination of monochromatic spectroheliograms of the solar surface made with other dark lines than those of calcium or hydrogen, which have been generally used up to the present. In 1906 the strong lines of iron at 4,040 and 4,380 were thus employed. Later, a much more powerful spectroheliograph has been employed, of 14 m. focal length, and with this it is possible to isolate the central cores of the dark Fraunhofer lines from the shaded edges, thus permitting the different solar atmospheric layers to be recognised. C. P. B.

2008. *Observations of Chromosphere.* **W. M. Mitchell.** (Astrophys. Journ. 30. pp. 75–85, Sept., 1909. Nature, 81. p. 498, Oct. 21, 1909.)—The author has installed a novel form of spectroscope at the Haverford Observatory, Pennsylvania. Instead of arranging the instrument in prolongation of the axis of the main telescope, it is fixed to the body of the instrument, and the light then reflected to the slit by means of suitable reflectors. By this arrangement it has been found possible to employ a very powerful spectroscope without the disadvantages due to flexure, &c., which would doubtless have arisen with the usual form of mounting. As an example of what the instrument can do, the author gives a table of chromospheric lines observed n a fine outburst on Jan. 21, 1909, at 7h.-9h. G.M.T., near the sun's east limb. It was also found possible to observe the Zeeman magnetic effect in spot spectra, and details of a series of measurements on May 11, 1909, are included. C. P. B.

2009. *Observations of the Surface of the Planet Mars, June 4 to October, 1909.* **R. Jarry-Desloges.** (Comptes Rendus, 149. pp. 587–590, Oct. 11, and pp. 664–667, Oct. 26, 1909.)—The planet was studied at two high-altitude observatories founded for mutual control, one on the Revard plateau (1,550 m.), the other near Massegros (900 m.). The Revard equatorial, with an objective of 0·37 m. aperture, is probably the most powerful refractor at such a high altitude in Europe. The Massegros objective is of 0·29 m. aperture. The earlier observations showed all the dark regions of the planet extremely pale, and very unlike what they appeared in 1907 at a similar Martian epoch. They darkened during Aug., and by Sept. had resumed their habitual tone of grey. Frequent measures were made of the diminishing polar cap. The diminution was particularly rapid about Aug. 15. Within the cap numerous dark rifts were seen, and also spots both grey and light. Important variations of form and extent, as well as tint, were noticed, especially in Mare Sirenum and Mare Cimmerium, which were at first pale and diffused, and later dark and well defined. Hellas altered from a large light region to a small and dark-ruddy one. The "canals," generally speaking, were invisible in June and July, becoming perceptible in Aug. and Sept. In Sept., at exceptionally clear moments, a multitude of fine details were perceived in certain greyish areas on Mars. The appearance of the surface on drawings of Sept. 16 and 18 but little resembles that on a planisphere given for June–July; the former showing numerous details and a wide range of gradation of tone, the latter only dim general features. The second paper deals with the canals, and contains two planispheres for July 20–Aug. 18, and Aug. 16–Sept. 23, that is for Martian late spring and early summer in the S. hemisphere, respectively. The canals are decidedly more numerous and conspicuous on the later map, which shows about 70 of them. The author classifies the canals under three groups: (1) Broad light grey bands; (2) narrow linear markings, fairly dark, and well defined; (3) fine lines, generally at the limit of visibility. The canals which were most conspicuous when they first began to appear were, of the 1st class, Ganges and Araxes; of the 2nd, Coprates, Nilosyrtis; and of the 3rd, Orontes, Typhonius. The author himself never saw with certainty any canal double, but some were seen double by his assistants G. and V. Fournier. Araxes, they saw first single, then double, and finally triple. Notable changes were witnessed in the visibility of certain canals, some becoming darker and more visible, others less so, as time went on. A remarkable fact was the disappearance of the broad dark band Achelous which was conspicuous in 1907 at the same Martian epoch. In summing up, the author states that certain bands of the first and second groups are seen at times with certainty, and all those mentioned in the article were seen by three observers. Some bands of the 1st class, when images are best, appear to resolve into elemental parts. He also finds it difficult to doubt the reality of the linear appearances of the 3rd class, numbers of them having been seen simultaneously by him and his two assistants at the Revard and Massegros. Though the author himself has not seen nearly so many as his two collaborators, he has yet seen a considerable number and at different reappearances, both in 1907 and 1909, about which he thinks there can be no mistake. A fact in favour of the existence of these canals of the 3rd class is that most (but not all) take their rise in little "gulfs" of the dark areas, just as the larger canals do in larger "gulfs." A. E.

2010. *Old Observations of the Eclipses of Jupiter's Satellites.* **R. A. Sampson.** (Roy. Astronom. Soc., Mem. 59. 3. pp. 119–256, 1909.)—The ordinary observations of eclipses of the Jovian satellites recording merely the instants of disappearance and reappearance, are subject to the vital defect that, whereas the real phenomenon is a gradual change of brightness of the satellite, similar to that of a variable star, one phase only is determined, and that not necessarily specified with sufficient accuracy for recognition in a rigorous discussion of the observations of different observers. Délambre's collection of 6,000 observations gives probably the most complete record, and these supply material for discussion of the three main elements requisite for determining the masses of the satellites and the ellipticity of the planet. These elements are (*a*) the motion of the node of Satellite II.; (*b*) the motion of the apse of Satellite IV.; (*c*) that portion of the equation of the centre of Satellite III. which refers to the apse of IV., for each of which a considerable span of time is essential or desirable. C. P. B.

2011. *Figure and Mass of Uranus.* **O. Bergstrand.** (Comptes Rendus, 149. pp. 333–336, Aug. 2, 1909.)—Direct observations of the disc of Uranus have not given good results for the determination of the flattening or the rotation period, and the author endeavours to utilise the observations of the movements of the two interior satellites, most of which have been made at the Lick Observatory since 1894. Taking a mean density for Uranus between that of Jupiter and Saturn, the author concludes that the polar flattening of Uranus is about 1/20, with a rotation period of 13 hours, and mass of 1/23300. C. P. B.

2012. *Motion of Neptune's Satellite.* **D. Gibb.** (Roy. Soc. Edinburgh, Proc. 29. pp. 517–536, 1908–1909.)—Soon after the discovery of the satellite by Lassel in 1846, it was pointed out by Marth that the node and inclination of orbit were slowly changing. Tisserand and Newcomb attributed these changes to the spheroidal shape of Neptune. Observations prior to 1892 have been discussed by Struve; in the present paper the author discusses the visual observations made since 1892. The inclination of the orbit of the satellite to Neptune's equator is found to be 21·2°; longitude of node =205·6°; inclination of Neptune's equator to the earth's equator, 132·8°. This value of the inclination implies a rotation of the pole of the satellite's orbit in about 580 years. From this it follows that the inclination of Neptune's equator to the ecliptic, which agrees closely with Neptune's orbit round the sun, is about 27°. C. P. B.

2013. *Motions of Stars in the Neighbourhood of the Clusters χ and h Persei.* **S. K. Kostinskij.** (Acad. Sci. St. Pétersbourg, Bull. 11. pp. 741–744, June 15, 1909.)—The author's previous investigations [Abstract No. 1518 (1909)] indicated that three stars in the vicinity of the aggregates χ and *h* Persei, and apparently certain other stars in the same region of the heavens, are moving nearly in one and the same direction, approximately ESE. The results of further research, by means of the Zeiss stereo-comparator, in this same region point to the existence of two star-streams, making an angle of 27°. It is hence supposed that all these stars are not connected physically with the clusters χ and *h* Persei. T. H. P.

2014. *Planetary Satellites.* **P. Lowell.** (Astronom. Nachr., No. 4351. p. 97, Aug. 27, 1909. Nature, 81. p. 315, Sept. 9, 1909. Abstract.)—Throughout the solar system there exists a remarkable parallelism between the ratios obtained by comparing the speeds of the satellites around their primaries with the velocities of the primaries in their orbits. C. P. B.

2015. *Double-star Measurements.* **J. B. Dale.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 629–631, June, 1909.)—The usual method of double-star measurement involves the direct determination of the polar co-ordinates of one star relative to another, but it is found that under such conditions well-defined systematic errors occur both in distance and position angle. As it is a well-established principle that the best method to eliminate systematic error is to vary as far as possible the conditions of measurement, a proposal is made for the adoption of such variation, the co-ordinates being measured from axes making a definite angle with the diurnal motion. C. P. B.

2016. *Eight Stars with Variable Radial Velocities.* **E. B. Frost** and **O. J. Lee.** (Astrophys. Journ. 30. pp. 62–67, July, 1909.)—The eight stars recorded are principally from the regular programme of Orion stars under observation with the Bruce spectrograph, with one prism and camera of 608 mm. focal length. The extreme velocities determined are: 68 Cassiopeiæ (—68 to —37 km.); 37 φ′ Orionis (+42 to +8 km.), this star being peculiar in that this variable velocity is only indicated by displacements of the calcium lines; 42 *c* Orionis (+58 to +33 km.); 139 Tauri (+21 to —9 km.); δ Scorpii (+22 to —30 km.); 72 Ophiachi (+15 to —12 km.); 43 φ Draconis (multiple lines); 59 *d* Serpentis (—47 to +10 km.). An attempt will be made to discover if any relation exists between the velocity and light variations. C. P. B.

2017. *Spectroscopic Binary β Orionis.* **J. S. Plaskett.** (Astrophys. Journ. 30. pp. 26–32, July, 1909.)—Various observers have from time to time obtained indications of variable velocity in the spectrum of Rigel (β Orionis), but in general the differences have been ascribed to difficulties of measurement owing either to the character of the lines or to the scarcity of comparison lines. Special photographs of the spectrum were taken at Ottawa during the available season of 1908, and until March 23, 1909, 275 plates being obtained on 55 nights. The measurements of radial velocity were confined to the lines 4481, 4472, and 4341. A range of about 10 km. was found, with a suggested period of 21·9 days. Several anomalies are presented, necessitating further study of the system. C. P. B.

2018. *Origin of Certain Lines in Spectrum of ε Orionis.* **N. Lockyer, F. E. Baxandall,** and **C. P. Butler.** (Roy. Soc., Proc. Ser. A. 82. pp. 532–545, July 31, 1909.)—Three groups of lines about the wave-lengths 4097·4, 4379·8, and 4647·6–4650·8 have been traced to their terrestrial origin. The lines 4097·4 and 4379·8 are now regarded as due to nitrogen; the double at 4647·6, 4650·8 is shown to be due to carbon. In all four cases the substances indicated only emit the special radiation corresponding to these lines under high electrical stress, such as is given by a heavy condenser discharge.

C. P. B.

2019. *Faint Companions of Procyon and Sirius.* **E. E. Barnard.** (Astronom. Nachr., No. 4845, p. 13, Aug. 7, 1909. Nature, 81. p. 229, Aug. 19, 1909. Abstract.)—During the last five or six years the angular motion of the companion to Procyon has been about 5·2° a year. By employing a special hexagonal diaphragm over the object glass the stray light is collected into a definite pattern and the small star is then more easily recognised. In the case of Sirius the angle of the companion is decreasing and the distance increasing. C. P. B.

2020. *Temperature of Algol.* **C. Nordmann.** (Comptes Rendus, 149. pp. 662–663, Oct. 26, 1909.)—In a note of Oct. 4 (ibid. p. 557) the author gave an indication of results furnished by his stellar heterochrome photometer concerning the effective temperatures of certain stars. He showed that the results obtained for the sun were of the same order as those obtained by the usual pyrheliometric processes. He now shows how an independent check on his result for the star Algol (β Persei) may be obtained. From the photometric and spectroscopic study of the variation of this eclipse star, together with data relative to its parallax, it has been proved directly that the brightness per unit surface of this star is very nearly 40 times as great as that of the sun. Also, the variation of brightness of an incandescent body emitting white light is, when its temperature varies, very fairly represented by the variation of intensity of the radiation corresponding to the maximum of luminosity in the normal spectrum ($\lambda = 0{\cdot}54\,\mu$). Planck's law gives, x being the effective temperature of Algol, and 6,000° about that of the sun—

$$\log 40 = \log(e^A - 1) - \log(e^B - 1),$$

where $A = 14600/(0{\cdot}54 \times 6000)$; $B = 14600/(0{\cdot}54 \times x)$. Whence, approximately, $x = 22{,}900°$. The temperature 23,800° was found by the author, using his stellar photometric method. A. E.

REFERENCES.

2021. *Hatchet Planimeter.* **A. Schreiber.** (Zeitschr. f. Vermess. 37. p. 689, 1908. Zeitschr. Instrumentenk. 29. pp. 318–320, Oct., 1909.)—A mathematical discussion of the theory of the hatchet planimeter. The paper does not admit of a brief abstract. A. W.

2022. *Harmonic Analyser.* **O. Mader.** (Elektrotechn. Zeitschr. 30. pp. 847–849, Sept. 9, 1909. Lumière Électr. 8. pp. 20–21, Oct. 2, 1909.)—The principle on which this analyser is based is the graphic method of harmonic analysis of Clifford, and in construction it resembles to a certain extent Youle's analyser. It is simple in construction and easy to manipulate, and gives very good results. For diagrams and theory see original paper. A. W.

2023. *Ballon-sonde Apparatus for recording Temperature.* **E. Gold and W. Schmidt.** (Meteorolog. Zeitschr. 26. pp. 318–321, July, 1909.)—Analysis of tests of a thermoelectric apparatus for temperature recording on sounding balloons for upper air temperatures. C. P. B.

2024. *Displacement of Axis of Meridian Circle.* **M. Hamy.** (Comptes Rendus, 149. pp. 185–190, July 19, 1909.)—Description of special apparatus and formulæ of reduction for determining the variation of orientation of the transit instrument axis. C. P. B.

2025. *Method of removing Astronomical Clocks from the Influence of varying Atmospheric Pressure.* **G. Bigourdan.** (Comptes Rendus, 149. pp. 758–756, Nov. 8, 1909.)—Description of an arrangement in which the clock is maintained under constant pressure by means of a supply of compressed air which is let into the clock-case by a barometric device when the pressure falls below the prearranged value. L. H. W.

2026. *The Balance as a Sensitive Barometer.* **G. W. Todd.** (Phil. Mag. 18. pp. 135–139, July, 1909.)

2027. *Mechanical Models for Engineering Students.* **E. Meyer.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1301–1307, Aug. 14, and pp. 1369–1372, Aug. 21, 1909.)—Gives a brief discussion of some important points in mechanics which it is desirable to illustrate by means of a model. Photographic reproductions of a large number of the most instructive of the models used by the author at Charlottenburg accompany the article. L. H. W.

2028. *Microscopy and Macroscopy in the Workshop and Foundry.* **J. E. Stead.** (Engineer, 108. pp. 379–380, Oct. 8, 1909. Engineering, 88. p. 477, Oct. 8, 1909. Paper read before the Internat. Assoc. for Testing Materials. Abstract.) F. R.

2029. *Experiments on the Forces acting on Twist Drills.* **D. Smith** and **R. Poliakoff.** (Inst. Mech. Engin., Proc. 2. pp. 315–381; Discussion and Communications, pp. 381–415, March–May, 1909. Abstracts in Engineering, 87. pp. 398–400, March 19; 432–438, March 26, and pp. 470–472, April 2, 1909. Bull. Soc. d'Encouragement, 111. pp. 1012–1022, May, 1909.)

2030. *Tests of Plain and Reinforced Concrete Columns.* **M. O. Withey.** (Eng. News, 62. pp. 300–303, Sept. 16, 1909. Paper read before the Amer. Soc. for Testing Materials, Atlantic City, June, 1909.)—Gives, in tables and curves, the results of tests made at the University of Wisconsin upon 20 columns, 10 ft. long, of five different types, and on 32 columns with spiral reinforcement, the variables being percentage of vertical steel, percentage of spiral steel, and richness of mix. The 600,000-lb. testing machine was used for the tests. L. H. W.

2031. *Design of Curved Machine Members under Eccentric Load.* **W. Rautenstrauch.** (Amer. Soc. Mech. Engin., Journ. 31. pp. 1071–1078, Mid-Oct., 1909.)—The author compares experimental results for the load (on iron and steel hooks) at elastic limit, with loads calculated from the ordinary formula and also with loads calculated after the formula based upon the analysis of E. S. Andrews and K. Pearson (Draper Company's Research Memoirs, 1904; Technical Series I.). The agreement between experiment and calculation in the latter case is extremely good, while the ordinary formula gives calculated values very much too high. Some simplifications of the formula are dealt with. L. H. W.

2032. *Mechanical Method for determining the Thrust of Propellers.* **J. H. Heck.** (Inst. Naval Architects, Trans. 51. pp. 87–96; Discussion and Correspondence, pp. 97–99, 1909. Mech. Eng. 23. pp. 514–519, April 23, 1909.)—A description of a hydraulic thrust-meter, with tables giving results of tests.

2033. *Report of the Experimental Tank Committee* (1908). Part II. by **R. T. Glazebrook.** (Inst. Naval Architects, Trans. 51. pp. 144–157; Discussion, pp. 157–163, 1909.)—Notes on a visit to new tanks in Germany and France, dimensions and sections of a number of these being given.

2034. *Accelerated Motion of Bodies in Water: the Rolling of Ships.* **A. W. Johns.** (Inst. Naval Architects, Trans. 51. pp. 179–189; Discussion, pp. 190–197, 1909.)

2035. *Diverging Waves.* **W. Hovgaard.** (Inst. Naval Architects, Trans. 51. pp. 251–261; Discussion and Correspondence, pp. 261–263, 1909.)—Partly in continuation of the author's work on ship resistance [Abstract No. 1769 (1908)].

2036. *Observations of Jupiter's Sixth, Seventh, and Eighth Satellites from Photographs.* (Roy. Astronom. Soc., Monthly Notices, 69. No. 9. pp. 673–676, 1909.) —Observations from photographs taken at Greenwich in 1909.

2037. *Minor Planets of Type ⅓.* **A. Prey.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 447–484, April, 1909.)—An extension is given of the mathematical discussion in C. L. Charlier's *Mechanik des Himmels* regarding the orbits and perturbations of planetoids of the type ⅓. A. D. R.

2038. *Comet* 1886 *V* (*Brooks I*). **G. Bucht.** (Ark. för Mat. Astron. och Fysik, Stockholm, 5. 1. pp. 1–45, 1909.)—Discussion of available observations from April to July, 1886, with the computed definitive orbit. C. P. B.

2039. *Motions of Ursa Major Stars.* **E. Hertzsprung.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 2. pp. 235–241, 1909. Astrophys. Journ. 30. pp. 135–143, Sept., 1909.)—Discussion of the proper motions and radial velocities of the associated system, including β, γ, δ, ϵ, ζ Ursæ Majoris, and the probability of a new member of the series existing in the star Sirius (α Canis Majoris). C. P. B.

2040. *Tidal Oscillations upon a Rotating Globe.* **Rayleigh.** (Roy. Soc., Proc. Ser. A. 82. pp. 448–464, July 26, 1909.)—Mathematical.

2041. *Solar Parallax.* **C. D. Perrine.** (Lick Observatory, Bulletin, No. 150. Nature, 80. p. 468, June 17, 1909. Abstract.)—Preliminary account of results obtained from observations of Eros at Mount Hamilton during latter part of 1900. The final value given is $8''\cdot8067 \pm 0''\cdot0025$. C. P. B.

2042. *Solar Parallax.* **A. R. Hinks.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 544–567, May, 1909. Solar Parallax Papers, No. 7. Comptes Rendus, 148. pp. 1030–1032, April 19, 1909. Abstract.)—The value of solar parallax from observations of the minor planet Eros during 1900–1901 is given as $\pi = 8''\cdot807 \pm 0''\cdot0027$. C. P. B.

2043. *Study of Planetary Atmospheres.* **N. Umow.** (Phys. Zeitschr. 10. pp. 259–260, April 15, 1909. Physikal. Inst. d. Univ., Moskou, March, 1909.)—Discussion of the application of spectrum absorption-band study to the analysis of planetary atmospheres. Reference is made to the occurrence of chlorophyll bands. C. P. B.

LIGHT.

2044. *New Astronomical Eyepiece.* **R. König** and **K. Satori.** (Zeitschr. Instrumentenk. 29. pp. 315–316, Oct., 1909.)—For the purposes of an astrophotographic time exposure the ordinary method of pointing the instrument at any object is carried out under certain disadvantages. A new and relatively simple eyepiece for the same purpose is described which is free from the defects alluded to and which makes use of no artificial illumination. A combination of the astronomical and terrestrial telescopes is made by placing behind a Huyghens eyepiece two small, centrally fixed plano-convex lenses which give an erect image, the effect being that two images are seen whose motions are in opposite directions. The sensitiveness of adjustment is at least double of that in which cross-wires are employed, and the additional eyepiece can be fitted to any telescope. G. E. A.

2045. *Testing Photographic Shutters.* **A. Campbell** and **T. Smith.** (Phil. Mag. 18. pp. 782–787, Nov., 1909. Paper read before the Physical Soc., May 14, 1909.)—This method for the determination of the duration of exposure given by a photographic shutter consists essentially of photographing on a moving plate a narrow beam of light reflected from the mirror of a vibration galvanometer which is electrically forced to make angular vibrations of known frequency (50 or 500 $\sim$ per sec.) about an axis parallel to the plate's motion. There is thus obtained a time graph on the plate, and by counting the number of half-waves the exposure is determined in hundredths or thousandths of a second. The paper gives full details of the optical and electrical arrangements together with photographic reproductions of specimen records. Measurements can be made to 0·0001 sec. E. H. B.

2046. *Reflecting Power of Metals as dependent on the Refractive Index of the Surrounding Medium.* **L. R. Ingersoll** and **R. T. Birge.** (Phys. Rev. 29. pp. 392–403, Oct., 1909.)—The object of this paper is an experimental study of the reflective power of the metals in liquids of various optical densities. The Fresnel reflection laws for surfaces of transparent substances apply equally well to such surfaces when overlaid or surrounded by a liquid if the index of refraction of the substance is taken as relative to that of the liquid. In metals we have a more complicated case, for the formula for reflecting power at normal incidence as stated by Drude—

$$R = [n^2(1 + k^2) + 1 - 2n]/[n^2(1 + k^2) + 1 + 2n],$$

involves two constants, n the refractive index and k the absorption index of the metal. For the case of a metallic surface in contact with a transparent medium of index other than unity the above formula is customarily extended by the assumption that the refractive index is then to be taken as relative to that of the medium, the absorption index remaining practically constant. The method of measuring the reflecting power, adopted in these experiments is that of comparison with a known standard by means of a spectrophotometer of the Martens-Koenig type. The conclusion arrived at is that the extension of the formula for the reflecting power of a metal in terms of its optical constants to include the case where the metal is covered by a transparent substance of any optical density is experimentally justified for the case of perfectly or practically perfect surfaces. The extension is made by replacing in the formula the actual refractive index, n, of the metal by the relative index n/m, where m is the index of the covering medium, the absorption index k of the metal remaining unchanged. When a surface has a reflecting power lower than its normal value for that metal this condition is due in most cases to the presence of minute scratches, corrugations, or indentations. While it is difficult to treat this case theoretically the experimental results indicate that for all this class of surfaces, as well as for those theoretically perfect, the relation $[1 - \mathrm{R}(\text{liquid})]/[1 - \mathrm{R}(\text{air})] =$ a constant, exists for any particular metal. A. E. G.

2047. *Refractivity of Minute Quantities of Gas.* **Rayleigh.** (Nature, 81. p. 519, Oct. 28, 1909.)—It is possible to obtain well-formed black bands on a sufficient angular scale with light which has traversed tubes 2 cm. long and ⅓ mm. in bore. A miniature Rayleigh refractometer was made by casting wax round two similar sewing needles, thus forming two parallel tunnels. The rest of the apparatus was an ordinary spectroscope arrangement without the prism. The purpose of the instrument was for the determination of the refractivity of radium emanation, and an accuracy of at least 1 per cent. is expected from the apparatus. G. E. A.

2048. *Diffraction Phenomena in the Ultramicroscope.* **K. Potzger.** (Ann. d. Physik, 30. 2. pp. 185–224, Oct. 14, 1909.)—An investigation of interference rings seen in the ultramicroscope when particles are under examination whose size is beyond the limit of resolving power of the microscope. In the first part of the paper a comparison is made between the effect and the Fraunhofer diffraction effects obtained when a natural or artificial star is viewed through a telescope. The second part contains the mathematical treatment of the problem, and the third part deals with experimental determinations. The results noted are: (1) The effects are not caused by the diaphragms in the objective; (2) the complicated diffraction effects can only be got rid of by the use of small diaphragms; (3) the diffraction effects of the ultramicroscope in normal use are due to the same cause as the extra bows in the rainbow phenomenon, namely, to the deformation of the wave-front after refraction at a spherical surface. Rings appear whose diameters diminish, and the numbers of which increase by external addition, as the objective approaches the object (first ring system). The second system is distinguished by broader rings which, under the same displacement of the objective, move in the opposite direction. G. E. A.

2049. *Spectrophotometers and Heterochromatic Photometry.* **J. Thovert.** (Journ. de Physique, 8. pp. 834–848, Nov., 1909.)—The author summarises the chief methods of photometrical adjustment used in instruments of the above class; thus interference has been utilised and also visual acuity, but the majority of these methods involve a considerable loss in illumination. It is preferable to aim at producing an approximately monochromatic field, and one sufficiently bright to enable the observer to use a simple photometer of the Foucault, Bunsen, and other types. The author then proceeds to describe, among other arrangements, an instrument utilising polarisation. He also enters into a mathematical discussion of the effective luminosity of a source in terms of wave-length, remarking, however, that in actual practice it is recognised as impossible to compare rigidly and numerically the capabilities of two heterochromatic sources either to reveal form or display colour. Nevertheless, he recognises that the tendency is towards the production of sources of light differing markedly in colour, and some convenient form of apparatus is therefore needed in order to enable an observer to ascertain readily how two illuminants differ in spectral composition. He next proceeds to describe another form of "technical spectrophotometer," the essential characteristic of which is that it can be used on an ordinary photometric bench, and for the comparison of sources of an intensity not less than 1 carcel, at a distance apart of 3 m. With this instrument the intensities of the sources in any desired portion of the spectrum can be compared. A yet further simplification consists in the use of a small direct-vision spectroscope which can be attached to an ordinary type of photometer and which will enable observers to compare the intensity of two illuminants in the red, green, or violet respectively. J. S. D.

2050. *High Purity Interference Phenomena of Chlorate of Potash Crystals.* **R. W. Wood.** (Phil. Mag. 18. pp. 585–587, Oct., 1909. Phys. Zeitschr. 10. pp. 916–918, Nov. 22, 1909.)—A flake of $KClO_3$ was obtained which exhibited at normal incidence total reflection of a spectral region only 10 or 12 Å.U. in width. The narrowness of the reflected region, as Rayleigh has shown, is due to multiple twin plates sensibly equidistant. From observations made with this particular crystal the author computes that there are 700 laminæ each about 0·0002 mm. in thickness. It is very remarkable that the laminæ are of such constant thickness in any one crystal and yet vary over such a wide range from crystal to crystal. A plate which starts with twin planes 0·0002 mm. apart apparently builds up 700 laminæ of the same thickness, while another plate starting with a different constant maintains it all the way throughout its growth. The author raises the question as to whether a crystal could be induced to change its constant by varying the temperature or concentration of the mother-liquor. E. C. C. B.

2051. *Application of Polarised Light to determine the Condition of a Body under Stress.* **S. P. Thompson** and **E. G. Coker.** (Chem. News, 100. pp. 161–162, Oct. 1, 1909. Paper read before the British Assoc. at Winnipeg, 1909.)—With the ordinary method for examining a transparent body under stress by means of polarised light, the body is placed between crossed nicols. Under these conditions the optical effect observed depends on the particular angle at which the specimen, or any part of it, is placed, and if the stresses are radial in direction, as with a short cylinder or circular disc of glass which has been suddenly cooled, a black cross is observed with its pairs of arms respectively parallel to the planes of polarisation of polariser and analyser, the light being a maximum for directions making 45° with these arms. These disadvantages are avoided by substituting circularly polarising apparatus for both analyser and polariser. For this purpose use is made of two thin plates of mica (or of quartz cut parallel to the axis of crystallisation) which give as nearly as possible a retardation of one-quarter wave-length for yellow light between their ordinary and extraordinary rays. Ordinary quarter-wave plates differ considerably among themselves, and it is important that the pair chosen should be alike in optical property. One must be large enough to cover the whole field of view, this being placed between the polariser and the object—preferably attached to the polariser—and set with its axis at 45° to the plane of polarisation of the polariser. The smaller quarter-wave plate is placed between object and analyser—best attached to the latter—so as to rotate with it, its axis being exactly at 45° to the plane of polarisation of the analyser. If this plate receives a beam of circularly polarised light, it transmutes that beam into plane-polarised light, which is either cut off or transmitted by the analyser, according to whether its own axis is at 45° to the left or to the right, that is, according as the cheirality of the analysing combination of quarter-wave plate and nicol is opposed to or concordant with the cheirality of the polarising combination. With this arrangement the black cross entirely disappears, and, with the exception of certain slight changes of tint, the optical appearance of any polarising object placed in the apparatus remains invariable at whatever angle that object is placed in the field. As a material more compressible than glass, and hence not so readily fractured, the authors employ a particular kind of xylonite; sheets 3–4 mm. in thickness being practically transparent, even 10-mm. thicknesses may be used. T. H. P.

2052. *Magnetic Rotation in the Infra-red.* **U. Meyer.** (Ann. d. Physik, 30. 3. pp. 607–630, Nov. 4, 1909. Extract from Dissertation, Berlin.)—The chief results of these elaborate experiments may be stated thus: With the crystals fluor spar, sylvin and rock-salt, on increasing the wave-length of the radiation there occurs a decrease of the magnetic rotation of the plane of polarisation. At a wave-length of 8·85 μ this rotation is less than 1 minute of arc for a crystal 1 cm. thick and a field of 10,000 gauss. The influence of the ions on this rotation is consequently very small in comparison with that of the electrons on Drude's theory. E. H. B.

2053. *Arc and Spark Spectra of Mercury.* **H. Stiles.** (Astrophys. Journ. 30. pp. 48–61, July, 1909.)—Using a concave Rowland grating of 10 ft. radius, the mercury lines were measured in relation to the system of International Standards given by Fabry and Buisson from interferometer methods. In order to eliminate any possibility of relative shift, the arc was arranged between carbon poles filled with an iron amalgam, so that the mercury lines should be photographed simultaneously with the iron standard lines. C. P. B.

2054. *Pressure-effect on Band Spectra of Fluorides.* **R. Rossi.** (Roy. Soc., Proc. Ser. A. 82. pp. 518–528, July 31, 1909.)—It has been suggested by W. J. Humphreys that lines which show a large Zeeman-effect ought to show a large pressure-shift, but no evidence of Zeeman-effect in the case of bands was known until Dufour observed it in the spectra of the fluorides of the metals of the alkaline earths [Abstracts Nos. 610, 613 (1908)]. The present investigation was undertaken to determine the effect of varying pressures on these bands. Using the first and second-order spectra of a 21½-ft. concave Rowland grating at the University of Manchester, the arc spectra of the fluorides of Ba, Sr, and Ca were photographed under pressures from 5–40 atmos. Each of the components into which a band was resolved was found to shift the same amount towards the red end of the spectrum. Owing to the asymmetrical reversal and widening of the components of these bands under pressure it is difficult to make accurate measurements, but tables are given showing the measured displacements as far as determined. From the discussion of the results it appears that although the bands which show Zeeman-effect are displaced by pressure, there is no definite relation between the magnitudes of the two effects. Neither does the amount of pressure-shift appear to depend on whether the circular polarisation agrees in direction with that deduced from the motions of the positive or negative electrons; the linear displacement seems to be similar to that found for line spectra. [See also Abstract No. 1814 (1907).] C. P. B.

2055. *Spectroscopic Investigation of the Arc under Reduced Pressure.* **A. Hagenbach.** (Phys. Zeitschr. 10. pp. 649–657, Oct. 1, 1909.)—An investigation of the copper arc in atmospheres of air, CO$_2$, coal gas and water-vapour at pressures varying from 1 atmo. to very reduced pressures. The spectrum of the different regions of the arc was photographed in each case. The type of discharge depends very much upon the pressure, the glow discharge becoming more pronounced the lower the pressure. The spectrum of the constituents of the surrounding atmosphere are to be seen, and there appears to be an equilibrium between the surrounding gas and the metallic vapour as the carrier of the discharge. There is a difference between the spectra at the two electrodes. At the negative pole the arc and spark lines of Cu prevail, while at the positive (hot) pole the spectrum of the atmosphere is strong. With long arcs the spectrum of the middle of the discharge is generally most like that at the positive pole. E. C. C. B.

2056. *Spectrum of Radium Emanation.* **H. E. Watson.** (Roy. Soc., Proc. Ser. A. 83. pp. 50–61, Nov. 3, 1909.)—The author has taken a number of photographs of the emanation spectrum and has compared them with those previously obtained by Cameron and Ramsay and by Rutherford and Royds. The wave-lengths measured in the present investigation, and also those recorded by the previous observers are given in a table. In an experiment by Cameron and Ramsay the spectrum obtained resembled very closely that of xenon. In this case copper electrodes were used, and the author suggests that the emanation under certain conditions has broken down into xenon. The spectrum described in the present paper and that of Rutherford and Royds [Abstract No. 1415 (1908)] fully confirm each other. J. J. S.

2057. *Zeeman-effect in Titanium Spectrum.* **A. S. King.** (Astrophys. Journ. 30. pp. 1–13, July, 1909. Contribution from the Mount Wilson Solar Observatory, No. 39.)—In a former paper [Abstract No. 654 (1909)] a list of selected titanium lines has been given with their separations under the magnetic field; the present paper gives a more exhaustive table of the behaviour of Ti lines from λ3900 to λ6600. The source of the spark was a 5-kw. transformer, with self-induction introduced to sharpen the lines. The majority of the photographs were taken with a field strength of 12,500 gauss, but at times a field of 18,400 was used. All photographs were made with the vertical Littrow spectrograph of 13 ft. (4 m.) focal length, fitted with a Nicol prism outside the slit for isolating either of the components of the polarised incident beam. From the tables of affected lines it is seen that while the great majority of the Ti lines are separated into triplets by the magnetic field, other types of separation are also well represented. The largest number of components observed was eight, in the line 4281·58; the longitudinal effect giving five, and the transverse three components. C. P. B.

2058. *Ultra-violet Absorption, Fluorescence, and Magnetic Rotation of Sodium Vapour.* **R. W. Wood.** (Phil. Mag. 18. pp. 530–535, Oct., 1909.)—The absorption of Na vapour is of two types, a Balmer series beginning with the D lines and extending into the ultra-violet, of which 48 members have been observed, and also the channelled spectra. The channelled spectrum in the visible region consists of two parts and, as the author has shown previously, there is a direct connection between it and the D lines.

The author now finds that channelled spectra accompany the other lines of the Balmer series, but they are not the counterpart of the one round the D lines, for they are not made up of two parts, but they spread in both directions both above and below the lines they accompany. There is also a similar connection between these channelled spectra and the corresponding lines in the Balmer series, for in the case of the Balmer line λ = 3303 if the vapour be illuminated with the light from the *Zn* triplet λ = 3300, the vapour fluoresces and emits the channelled spectrum. There is no connection between the ultra-violet and the visible channelled spectra. It would appear that the different lines of the Balmer series and their accompanying channelled spectra are produced by different entities. The author favours the view that the Balmer lines and their accompanying spectra are caused by atoms which have lost 1, 2, 3, 4, &c., electrons. As regards the magnetic rotation, it is found that the rotation of the first two Balmer lines in the ultra-violet is in the same direction as at the D lines. E. C. C. B.

2059. *Homogeneous Corpuscular Radiation.* **C. A. Sadler.** (Nature, 81. pp. 516–517, Oct. 28, 1909.)—A summary is given of the results of investigations upon the corpuscular radiations excited in various metals when homogeneous secondary beams are employed as primaries instead of heterogeneous primary beams. (1) With homogeneous beams, when the primary beam is only just more penetrating than the secondary Röntgen radiation characteristic of the metal, the intensity of both the secondary Röntgen radiation and the corpuscular radiation is small. For a slightly more penetrating primary beam a rapid increase in the intensity of both the secondary Röntgen radiation and the corpuscular radiation takes place. Thus the production of the latter appears to be in some way intimately associated with the emission of the former. (2) When homogeneous radiation falls upon a thin layer of a substance which may act as a secondary radiator a portion is transmitted unchanged, and it is found that the fraction of the remaining energy which is transformed into corpuscular radiation increases as the primary beam becomes more penetrating. (3) The corpuscular radiation emitted by these metals when subjected to homogeneous beams is itself surprisingly homogeneous, whether the exciting beams are soft or very hard. (4) The absorption coefficients of the corpuscular radiation from a given metal excited by homogeneous secondary Röntgen radiation vary with the nature of the exciting radiation. These absorption coefficients are a decreasing linear function of the atomic weight of the secondary radiator. J. J. S.

2060. *Polarisation of Secondary γ-Rays.* **R. D. Kleeman.** (Roy. Soc., Proc. Ser. A. 83. pp. 40–49, Nov. 3, 1909.)—Experiments were made to test whether the secondary γ-rays are polarised. Radiation from radium was allowed to fall on a cylinder of wood, with a hole through it along the axis, which served as secondary radiator. This cylinder was placed in front of an electroscope protected by lead. The side of the electroscope facing the radiator consisted of zinc 3·5 mm. thick, and the window facing the radiator was of glass 6 mm. thick. The angle θ between the lines joining the centre of the cylinder to the radium and to the leaves of the electroscope was made to vary, and the leaks obtained with and without the radiator and with different quantities of Ra were observed. When the leaks per minute are plotted against the angle θ the curve has a sharp bend at $\theta = 90°$. According to the ordinary theory the radiation curve ought to show a decided minimum at 90° and to rise to an equal extent on either side of this value of θ. The radiation at 90° being taken as unity, the radiation at 45° would be 1·38, and at 135° it would be 1·52, correction being made for absorption. But the experimental values obtained were widely different, being about 1·1 for 45° and 2·7 for 135°. The secondary radiation in the direction of propagation of the primary radiation is much greater than in the opposite direction, being about three times as great. This was confirmed by other experiments. The radiation in a plane containing the primary rays and the radiator passes through a minimum at right angles to the primary rays. The effects observed may be due to the existence of polarisation in the case of the γ-rays. The author intends to make further tests by a different method. J. J. S.

2061. *Multiple Atomic Disintegration.* **F. Soddy.** (Phil. Mag. 18. pp. 739–744, Nov., 1909.)—The cause of atomic disintegration remains unknown. What may be termed the inevitableness of the process, and its entire independence of all known conditions, suggests that the cause of disintegration is apart from the atom. It is difficult to believe that the cause is resident in the space external to the atom. It seems more probable that it exists within the atom, and at the same time is uninfluenced by it. The question discussed in this paper is whether necessarily only one mode of instability can exist within the atom at the same time. The same element, *e.g.*, uranium, may give rise to two different series of disintegration products, actinium and radium. Rutherford has suggested, in order to account for the small quantity of Ac relatively to Ra in minerals, that Ac may be formed from Ur as a side or branch chain, not in the main line of descent. The suggestion in this paper is that multiple modes of disintegration may be proceeding simultaneously and independently within the same atom. It has been established that the period of actual life of the individual remains indefinite up to the moment of disintegration, and no process of sorting a collection of atoms into long-lived and short-lived varieties is even conceivable. Similarly for multiple disintegration the view advocated is that the law of simple disintegration applies to each mode of disintegration exactly as if it were the only one in operation. If for the same atom two modes of disintegration can occur independently, the constant of the first mode being represented by λ_A and that of the second by λ_X, the quantity Q of the substance will diminish according to the differential equation—

$$dQ/dt = -\lambda_A Q - \lambda_X Q \quad \text{or} \quad Q_t/Q_0 = \epsilon^{-(\lambda_A + \lambda_X)t},$$

where Q_t is the quantity remaining at the time t and Q_0 is the initial quantity. That is to say, for a radio-element undergoing a dual disintegration the quantity would diminish exponentially with the time as in a simple disintegration. There will be a constancy of proportionality between the products formed in the various modes of disintegration. A concrete example is worked out on the assumption that the disintegration of UrX is dual, one mode producing ultimately Ra and the other Ac, and it is found that this point of view explains perfectly the known relations between Ur, Ac, and Ra. If one of the modes of disintegration were a relatively mild form of rearrangement rather than an explosive disintegration, it is conceivable that the ray-producing change might occur with the same period independently of whether the rayless change had or had not occurred, expelling the same character of ray in each case. On this view Ac would proceed from rearranged but undisintegrated UrX, Ra from UrX disintegrating directly, or *vice versâ*. If λ_A represents the constant of the rayless, and λ_X that of the ray-producing mode of disintegration, it can be shown for this case that the rays will now follow the exponential changes with their own true period λ_X, rather than with the $\lambda_A + \lambda_X$ period. This holds true whether the rearranged UrX is present or absent initially. At the present time there is no experimental evidence either for or against the view that the disintegration of UrX is multiple. A. E. G.

2062. *Uranium Disintegration.* **J. A. Gray.** (Phil. Mag. 18. pp. 816–818, Nov., 1909.)—A discussion of the ultimate product of the Ur disintegration series. Boltwood has given some evidence tending to show that lead is the ultimate product of the series [see Abstracts Nos. 2059 (1905), 648 (1907)]. The author has examined spectroscopically specimens of antunite and torbernite from different localities, and his results confirm Boltwood's conclusions. He also finds that the formation of 10^{-4} gm. of lead from uranium would take about a million years. A. W.

2063. *Typical β-radiation from Radium Proper.* **O. Hahn** and **L. Meitner.** (Phys. Zeitschr. 10. pp. 741–745, Nov. 1, 1909. Chem. Inst. d. Univ., Berlin.)—A description of experiments carried out with the view of ascertaining whether Ra itself sends out any β-radiation. A full account of the method of preparing the substances used is given, and the results are shown graphically. The general results of the work are as follows: The β-rays from Ra preparations do not originate, as has up to the present been accepted, solely from RaB, RaC, and RaE_2, but Ra itself gives out a typical β-radiation. This radiation can be distinguished with absolute certainty from the other β-radiations by its penetrating powers. One half of these β-rays are absorbed by 0·00222 cm. of aluminium, so that they possess an absorption coefficient represented by $\lambda = 312$ cm.$^{-1}$. According to the hypothesis put forward by the authors, that complex rays correspond to complex substances, Ra must be now considered as a complex substance because of the presence of this β-radiation. Further experiments are in progress. A. E. G.

2064. *Secondary Radiation from Solids, Solutions, and Pure Liquids by the β-Rays of Radium.* **S. J. Allen.** (Phys. Rev. 29. pp. 177–211, Sept., 1909.)—The rival theories of J. J. Thomson and Bragg as to the cause of secondary radiation are first considered. A detailed account of the experimental arrangements is then given. The results obtained are set out both in tabular and graphical forms. For the fifteen elements in the solid state these show that with the exception of palladium the radiation follows the order of the atomic weight of the substance struck. The values for Ag and Pd are very close to one another, and the difference is probably due to experimental errors. It is also concluded that when using a large angle of incidence the average penetrating power of the rays from substances of low atomic weights is much greater than when the angle of incidence is normal. In the case of powdered salts the radiation does not follow, in general, the order of the molecular weights. The effect of an atom of high atomic weight can, however, be readily seen by an increase in the radiation. An attempt is made to show that the radiation due to the presence of a metal in a bichloride salt is a function of the atomic weight of the metal. In the experiments with aqueous solutions of salts the solution to be tested is placed in a glass cylindrical cell, the surface of the liquid being always at the same level and depth. A large number of these are tested. For those solutions which contain only atoms of low atomic weight the increase of radiation due to solution is nearly proportional to the concentration even for high concentrations. Solutions containing atoms of high atomic weight give a radiation which is approximately proportional to the concentration of the solution for low concentrations; but as the concentrations increase, the curves depart more and more from a straight line, and seem to approach a limiting value. This is quite noticeable in the curves for lead nitrate and potassium iodide solutions. In all cases the presence of atoms of high atomic weight is responsible for a large radiation, and, moreover, in a group of salts which have a common constituent of the same amount, the radiation due to the other constituent increases very rapidly with the atomic weight, being in the cases considered nearly proportional to the square. Lastly, the radiation from a large number of pure liquids is tested, and the results obtained from these are arranged in groups. The water group contains water, alcohols, ether, and acetic anhydride. In this group, with the exception of allyl alcohol, the secondary radiation is the same, and about 25 per cent. less than that of pure water. In the acid group are a number of organic acids. Propionic, butyric, and caprylic acids show nothing unusual, and give radiation about the same as the alcohols, though the number of atoms differs largely. The ester group also gives about the same radiation as alcohol. In the hydrocarbons, benzene, toluene, nitrobenzene, and ethylbenzene give the same radiation as alcohol. Amylene is an exception in this group, giving only 65 per cent. as much as pure water. The compounds of the amine group all give the same radiation as alcohol. In the halide group the radiation follows the order of the atomic weight of the chlorine, bromine, and iodine constituents, but there are several remarkable exceptions. The absorption of the β-rays by pure liquids and of the secondary rays by tin-foil is also considered. It is found that the solids are more efficient absorbers than the liquids for equal atomic weights. The absorption of γ-rays by liquids follows in general the order of the atomic weight of the heaviest atoms; the density of the liquid seems, however, in certain cases to have a large effect. A. E. G.

2065. *Proof of the Complex Nature of Radium C.* **O. Hahn** and **L. Meitner**. (Phys. Zeitschr. 10. pp. 697–708, Oct. 15, 1909. Chem. Inst. d. Univ., Berlin.)—This paper contains an account of work done in order to establish the complex nature of RaC—a conclusion at which the authors had already arrived as the result of previous experiments [see Abstract No. 1702 (1909)]. The results now obtained may be summarised as follows: The examination of the β-rays of the active deposits of Ra makes it clear that RaB is a simple substance; RaC, however, clearly emits complex β-rays. On the ground that complex β-rays must of necessity be given off by a complex substance, RaC must be regarded as complex. This has now been proved by experiment to be the case. An activity is produced by the "recoil" method, the decay period of which varies between 1 and 2·5 min. RaC consists at least of two substances, RaC_1 and RaC_2. Again, RaC_2 also consists of two substances, one of which has a decay period of a few seconds, the other a period of 2 to 2·5 min. A. E. G.

2066. *Kathode Separation of Induced Thorium Activity from its Solution in Hydrochloric Acid.* **H. Sirk.** (Akad. Wiss. Wien, Sitz. Ber. 118. 2a. pp. 863–871, April, 1909. From the Physikal. Inst. d. k.k. Univ., Graz.)—The method of obtaining the induced activity of thorium in solution is first dealt with, and then the experimental details are given. It is found within the limits of this research that the separated activity is proportional to the concentration of the solution. With increasing current the amount of activity separated also increases, but in a much slower ratio. Platinum and silver when used as material for the kathode seem to give the same results, but Cu kathodes show a stronger activity than kathodes of Pt. The p.d. between the two electrodes makes little difference in the activity, thus 1·4 volts to 6·5 volts give activities on the kathode represented by 8 and 10 respectively. The activity collected likewise increases with the time during which the current flows, but is not proportional to the time, the increases in the activities being in all cases too small. A. E. G.

2067. *Active Deposit from Actinium in Uniform Electric Fields.* **W. T. Kennedy.** (Phil. Mag. 18. pp. 744–757, Nov., 1909. Paper read before the Royal Society of Canada, May 26, 1909.)—Previous investigators do not appear to have taken any precaution to study the behaviour of the active deposits with uniform electric fields, and this is the object of the present experiments, in which the emanation from actinium is used for this purpose. The apparatus and the method of carrying out the experiments are described. It is found that, as the electrodes are separated, the activity obtained on both plates steadily decreases. With distances apart greater than 8 mm. no measurable activity is obtained on the anode, but with the greater distances, viz., 8 mm., the active deposit obtained on the kathode is still about one-half that obtained on the same terminal for a separation of only 1 mm. For all pressures the activity obtained on both electrodes steadily decreased as the distance between the salt and the electrodes is increased. In experiments on the activity of deposits in air dependent upon pressure, the curves obtained for both electrodes follow similar laws. The activity on both electrodes steadily rises as the pressure falls, both pass through maximum values, and both fall away again and approach equality at the lowest pressure. The max. activity for the kathode is obtained at a pressure of 80 mm., while that in the anode is not obtained until a pressure of 17 mm. is reached. The max. kathodic deposit is only about 2·75 times that obtained on the anode. Curves obtained with CO_2 follow laws similar to those obtained with air, and the deposits on the two electrodes gradually increase as the pressure is lowered. Both pass through a maximum, and for still lower pressures the active deposits on both plates decrease and approach equality for the lowest pressure investigated. For hydrogen the ratio of the max. activities for the two terminals is only slightly less than the corresponding ratios for air and CO_2. A table of comparison of the active deposits in air, CO_2, and hydrogen is given. From the ratios of the coefficients of diffusion of the active deposits as deduced from the kathode deposits, it seems that a diffusion phenomenon is the paramount one in the present investigations. The active deposits obtained in the absence of electric fields show that the total active deposit is practically the same with and without the field at all pressures above the critical pressure. At and below this pressure the deposits obtained with the electric field applied are somewhat in excess. From this experiment it would seem that the deposit particles in a very great measure go to the walls of the vessel in which they are produced, whether an electric field is applied or not. It is concluded that in the region of low pressure there is a gradual decrease both in the excess of positively charged deposit particles and also in the total number of particles present in the space between the electrodes. The experiments, however, do not show whether this decrease is due to a falling off in the amount of emanation coming into this space, or in the amount of emanation and deposit particles passing directly through it into the outer chamber of the apparatus. From the fact that at low pressures as well as at high ones the activity falls away as the distance of the salt from the electrodes is increased, it would seem that the decrease is due to decrease in the amount of emanation entering the space between the electrodes. This matter requires further investigation. A. E. G.

2068. *Radio-active Minerals in Common Rocks.* **J. W. Waters.** (Phil. Mag. 18. pp. 677–679, Oct., 1909.)—The object of this investigation is to find in what minerals the radio-activity of igneous rocks is most concentrated, and, if possible, to separate them with a view to their use as material for finding the age of rocks in which they occur. The first material examined is rotted Cornwall granite from which kaolin and mica have been removed at a china-clay works. In this case it appears that the radio-activity is concentrated in the heavier minerals. After removing the last traces of magnetic matter from the heavier constituents by a very powerful magnetic field, a powder is obtained in which the radio-activity appears to be concentrated. Spectroscopic examination of the final product shows that titanium is present in large quantity. The mineral is therefore considered to be anatase or rutile. About ⅓ gm. of this final mineral is obtained from 2–3 lbs. of original material, and is found to contain about 1·5 cub. mm. helium per gm. Gneiss from the Inner Hebrides is also tested in a similar manner. This yields about 0·1' gm. active material per lb. of rock. The active matter in this case consists of zircon. Experiments on other rocks are in progress.

A. E. G.

2069. *Radium in New Zealand Rocks.* **C. C. Farr** and **D. C. H. Florance.** (Phil. Mag. 18. pp. 812–816, Nov., 1909.)—A paper giving the radium-content of certain igneous rocks from the sub-Arctic islands of New Zealand. The mean value obtained approximates very closely to that found for other igneous rocks by Strutt and by Eve and McIntosh [see Abstract No. 71 (1908)], but differs considerably from Joly's values. The Ra-content corresponds roughly with the basicity of the rocks, not with their age. A. W.

2070. *Heavier Gases of the Helium Group in Minerals.* **C. F. Hogley.** (Phil. Mag. 18. pp. 672–677, Oct., 1909.)—This paper is divided into two parts, one dealing with argon in malacone, and the other with krypton in fergusonite. Several experimenters have found that the quantity of argon in malacone is appreciable, and in excess of the quantity of helium contained [see Abstract No. 1810 (1908)]. This Strutt has failed to confirm. The great source of error likely to occur in dealing with argon is by contamination of the gas with air, and the apparatus used is constructed to eliminate the possibility of this error. The helium is liberated in one experiment by decomposing the mineral with potassium bisulphate, and in the others by simple heating, but there is no appreciable difference in the results. These experiments show that argon is contained in malacone in only minute quantities even in comparison with helium. It is true that the gases are not entirely expelled by simple heating, but this would not account for the great discrepancies between the results of the various experimenters, and can scarcely affect the general conclusion. If the presence of krypton in certain minerals is in any way connected with their radio-active properties one might expect to find that this element is a constituent of all the strongly radio-active minerals. It has been reported as present with the helium obtained from cleveite. The mineral used for this investigation is fergusonite, which gives off about 1 c.cm. helium per gm. on heating. The method of conducting the experiments is described, and the apparatus used is illustrated by two diagrams. The amount of helium given off by the mineral used is about 100 c.cm. Had $\frac{1}{10}$ c.cm. of krypton been present with it, the spectrum analysis of the gas would have made this apparent. No evidence of this kind is obtained, hence the experiment points to the conclusion that krypton, if present at all, which is indeed doubtful, must amount to less than one part in a million of the helium-content. It is intended to continue experiments with other strongly radio-active minerals. A. E. G.

2071. *Suggested Lunar Influence on the Amount of Atmospheric Radio-activity.* **P. Besson.** (Comptes Rendus, 149. pp. 595–597, Oct. 11, 1909.)—Ten measurements of the amount of radio-active emanation present in the gas from 3 litres of water from the spring at Uriage-les-Bains, made during July and Aug., 1908, have been grouped so as to compare the amounts collected under similar conditions of atmospheric pressure (1) with the moon over the meridian of the place; (2) with the moon over the antipodeal meridian. The former measurements exceed the latter roughly in the ratio 18/9. Though admitting that it is inadmissible to draw definite conclusions from this evidence, the author suggests the possibility of a lunar influence.

R. G. K. L.

REFERENCES.

2072. *A Telescopic System.* **E. Gatti.** (Accad. Sci. Torino, Atti, 44. No. 13. pp. 430–440, 1908–1909.)—Proves that in a dioptric system with identical terminal media the linear enlargement is determined by the square root of the negative differential coefficient of the distance between the image and the second principal plane of the last lens, taken with respect to the distance between the object and the first principal plane of the first lens. E. E. F.

2073. *Models for the Wave-surface in Mirage.* **A. Garbasso.** (N. Cimento, 18. pp. 25–32, July–Aug., 1909.)—The theory of mirage, says the author, referring to his own works, depends on the study of Fourier's equation. Changing the surface conditions, we change the number and nature of the images. The different cases are then considered mathematically. **E. Ciani.** (Ibid. pp. 33–45, July–Aug., 1909.) —A commentary on Garbasso's note. S. H. B.

2074. *Theory of Light.* **T. Tommasina.** (Comptes Rendus, 149. pp. 627–629, Oct. 18, 1909.)—Discusses the propriety of readmitting the possibility of a longitudinal component in the vibrations constituting light now that its pressure is an experimental fact. E. H. B.

2075. *Thermodynamics of Grating Diffraction.* **M. Laue.** (Ann. d. Physik, 30. 2. pp. 225–239, Oct. 14, 1909.)—Discusses mathematically the thermodynamics of diffraction at a grating of infinitely long and infinitely numerous lines. [See also Abstract No. 1416 (1906).] E. H. B.

2076. *Phosphorescence Bands.* **A. Werner** and **H. Gohdes.** (Ann. d. Physik, 30. 2. pp. 257–272, Oct. 14, 1909.)—A study of the relation between the lasting and evanescent processes concerned in phosphorescence. The separate and combined intensities of emission are shown in four sets of curves. [See also Abstract No. 726 (1905).] E. H. B.

HEAT.

2077. *Contraction of Gold Leaf at High Temperatures.* **J. C. Chapman** and **H. L. Porter.** (Roy. Soc., Proc. Ser. A. 83. pp. 65–68, Nov. 3, 1909.)—It has been shown by T. Turner [Abstract No. 1933 (1908)] that gold leaf appears to become transparent when heated in contact with glass. Experiments are made in which gold leaf is heated within a fused quartz crucible while its change of length and temperature are measured. It is found that at 340° C. the gold leaf begins to contract, and the subsequent contraction is much greater than the initial expansion. The temperature at which the leaf contracts is independent of the tension; also, when very fine gold wire is used instead of leaf, there is no contraction. The effect is explained as due to the surface tension overcoming the rigidity of the gold leaf. G. E. A.

2078. *Specific Heats of Silicates and Platinum.* **W. P. White.** (Amer. Journ. Sci. 28. pp. 334–346, Oct., 1909.)—Specific heats of silicates show a considerable increase with temperature up to 700° C., followed by a tendency to diminish at higher temperatures. Curves are given showing the observed mean specific heats from zero, and the table gives the deduced true specific heats, except that of quartz, which is omitted for want of additional data in connection with the inversion at 575° :—

Temperature, °C.	500.	700.	800.	900.	1,100.	1,300.	1,500.
Platinum	0·0356	0·0368	—	0·0380	0·0390	0·0400	0·0407
Wollastonite	0·251	0·263	—	0·262	0·261	—	—
Pseudo-wollastonite	0·250	—	—	—	0·259	0·257	—
Orthoclase	0·257	—	0·272	—	0·279	—	—
Diopside	0·262	0·272	—	0·281	0·286	0·278	—
Orthoclase glass	0·264	—	0·282	—	0·297	—	—
Soft tubing glass	0·298	0·324	—	0·340	0·335	0·333	0·332

The formula for the mean specific heat of platinum is $0{\cdot}03198 + 3{\cdot}4 \times 10^{-6}\theta$; and that for diopside ($CaMgSi_2O_6$) is $0{\cdot}1779 + 1{\cdot}516 \times 10^{-4}\theta - 1{\cdot}047 \times 10^{-7}\theta^2 + 2{\cdot}81 \times 10^{-11}\theta^3$.

The method of mixtures was used. The crucible and sample were dropped into a calorimeter completely enclosed by its water-jacket. A temperature-rise of as much as 28° was in some cases used. The chief source of error is the want of uniformity in the furnace temperature. The mean specific heats are considered to be accurate within 0·5 per cent. at most of the temperatures; the true specific heats are not so accurate. F. R.

2079. *Latent Heat of Vaporisation of Water and the Specific Volume of its Vapour between* 80° *and* 180° *C.* **F. Henning.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 1768–1769, Oct. 23, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—The author gives an account of some experiments he has made on the direct determination of the latent heat of vaporisation of water. He makes use of two pieces of apparatus, one for the range of temperature 30–100°, and the other for the range 100–180°. Both are constructed on the same principle, the latter one, however, being considerably larger than the former. The method adopted was to pass a known current through a coil under a known pressure-difference and measure the electrical energy consumed. The coil was immersed in a metal vessel containing the water, which was thereby boiled under any desired pressure. The vapour produced was led into a condensation flask, and the mass of water condensed in 15 to 50 min., was determined. In order to diminish the loss of heat from the boiler it was surrounded by an electrically heated oil-bath. Taking the value of the mechanical equivalent of heat in terms of the calorie at 15° C. as $4{\cdot}188 \times 10^7$, the value of the latent heat is obtained to 0·1 per cent. By the application of the Clapeyron-Clausius equation the specific volume of the vapour is obtained at various temperatures, the results of Holborn and Henning on the vapour pressure of water [Abstract No. 858 (1909)] being assumed for the purpose. The author's results for the total heat at 80° are in exact agreement with Regnault's determinations; below that temperature his results are lower, above it they are higher. W. C. S. P.

2080. *Radiation Exponent of Dry Air.* **W. J. Humphreys.** (Astrophys. Journ. 30. pp. 20–25, July, 1909.)—In the usual method of examining radiation and absorption phenomena in gases contained in vessels of various kinds, a certain degree of trouble arises from the action of the walls of the vessel. In searching for a natural indication without such interference we have the fact that the records of sounding balloons show that everywhere the temperature of the atmosphere decreases more or less regularly with increase of elevation until, in middle latitudes, about —55° C. is reached at an altitude of about 11 km.; above this altitude, where the air is excessively dry, the temperature changes but little with change of elevation. In consequence there will be very little convection, and the temperature will depend almost entirely upon radiation and absorption. A test set of temperatures are analysed, giving an exponent nearly the same as for black-body radiations. C. P. B.

2081. *Total and Monochromatic Radiation from Incandescent Lamps.* **C. Féry** and **C. Chéneveau.** (Comptes Rendus, 149. pp. 777–779, Nov. 8, 1909.)—If the absolute temperature T of a carbon filament glow-lamp is measured when the power in watts expended on it is W, it is found that $W = aT^4$, where a is $2{\cdot}95 \times 10^{-12}$, represents very accurately the law connecting T and W. This shows that the losses by conduction and by convection are negligibly small when the temperature of the filament lies between 1,500° and 1,900° C. In this case Stefan's law is sufficient to explain the phenomenon. The authors have also found that the law connnecting the luminous intensity I and the power W expended is of the exponential form. From the laws of monochromatic radiation and displacement combined with the above law they find that $I = 2{\cdot}08 \times 10^{6}\epsilon^{-\alpha}$, where $\alpha = 82{\cdot}05/W^{1/4}$. This law has been verified between wide limits by ordinary photometric methods. With metal filament lamps the specific radiation is different from that of carbon filament lamps. The authors have assumed that the radiation from an unoxidisable metal like platinum when heated in air would be approximately the same as that from a tungsten filament at the same temperature. By an optical pyrometer they find that for platinum $W = a_1 T^{4{\cdot}6}$, where $a_1 = 1{\cdot}89 \times 10^{-12}$. Assuming that this law holds for a tungsten filament, they deduce that $I = 3{\cdot}08 \times 10^{6} \times \epsilon^{-\beta}$, where $\beta = 27{\cdot}68/W^{1/4{\cdot}6}$, is the law that connects luminous intensity and power expended for a tungsten filament. These laws show that during normal working the temperature (1,780° C.) of the carbon filament is less than the temperature (1,875° C.) of the tungsten filament. The specific efficiency [0·82 candle/watt] of a metal filament lamp is greater than that [0·29 candle/watt] of a carbon filament lamp. This fact has been long known in practical work. The authors now show that it follows from theoretical considerations. A. R.

2082. *The Nozzle Expansion of Air at High Pressures.* **W. P. Bradley** and **C. F. Hale.** (Phys. Rev. 29. pp. 258–292, Sept., 1909.)—When a permanent gas is cooled by expansion through a throttling valve or nozzle it is usually supposed that the cooling is due to the Joule-Kelvin effect, and may be represented by the formula $d = 0{\cdot}276(p_2 - p_1)(273/T)^2$, where p_2, p_1 are the initial and final pressures in atmos. and T is the initial temperature on the absolute scale. Pictet, however, insists that the heat absorption is due to the external work in overcoming the pressure which prevails in front of the valve, and that pressures higher than 25–30 atmos. have no considerable influence on the cooling effect, unless the liquefier is grossly deficient in interchanger surface. According to Pictet the cooling effect also decreases with decrease in the initial temperature. The present authors have made experiments to test these points of difference, and have worked on air at initial temperatures from +20° to −120° and initial pressures from 68 to 204 atmos. For the measurement of temperatures they employed four Pt thermometers, one on the high-pressure side of the valve and three below the valve and at different distances from it, each being separated from its neighbour by about 4 cm. They found, as did Kelvin and Joule, that the thermometer nearest the valve recorded the lowest temperature, and that one furthest away the highest; but at the temperature of liquefaction they all gave the same reading. These differences are due to the high velocity at which the blast enters the outflow tube through the orifice at the top, and the true final temperature is considered as that recorded by the last thermometer. Their curves between the cooling and initial temperature show conclusively that for a given pressure the final temperature falls off more rapidly than the initial temperature, and they find that at no pressure between 68 and 204 atmos. is it necessary to cool the air on the high-pressure side to the critical temperature in order to produce liquid air. It is certain that the use of high pressure does not tend to promote liquefaction in the high-pressure circuit, as stated by Pictet, but just the reverse. Their curves are similar to those calculated from the results obtained from the Joule-Kelvin effect as applied to the liquefaction of air by Linde; but they are in no way similar to the curves obtained by the application of Pictet's formula. In particular the authors find that for moderate initial temperatures the cooling effect is less than that called for by the Joule-Kelvin formula, and the disparity becomes increasingly greater as the pressure increases. This formula gives a much smaller cooling effect for low pressures and low initial or final temperatures than that which they have observed. At high pressures their curves tend to become nearly parallel to those calculated from the formula. Using outflow tubes of different diameters they find that the "velocity cooling" is a negligible factor in the total cooling effect, except very close to the valve. Two formulæ are given for the cooling effect, obtained from their experimental data. In conclusion, the authors suggest that the phenomena connected with the Joule-Kelvin effect and the inversion temperature of a gas can be explained by J. Traube's theory of the gaseous and liquid states. W. C. S. P.

2083. *Note on Thermodynamics.* **Brillouin.** (Annal. Chim. Phys. 18. pp. 191–196, Oct., 1909.)—When we know the law of elasticity of a body, the transformations of which are reversible, in terms of the geometric variables and the temperature, we know, as Kirchhoff pointed out, that a knowledge of the specific heat in terms of the temperature only will suffice to determine all the properties of the body from the thermodynamic point of view. The author proves that the calorimetric experiments can be replaced by a series of mechanical experiments on the adiabatic elasticity of the body or by resonance experiments noting the temperature only. The great interest of these experiments would be to find out whether the function expressing the specific heat at constant pressure in terms of the temperature would alter much in the neighbourhood of the critical pressure. We are justified in concluding that any complication in the neighbourhood of the critical point will be completely defined by the law of elasticity alone. To make sure of this it is only necessary to make measurements of the adiabatic elasticity of carbon dioxide for every 5° interval from 0° to 60°. It does not seem impossible to make measurements in this way even in the neighbourhood of the critical state. A. R.

2084. *Isotherms of Monatomic Gases and Their Binary Mixtures.* III. *Data concerning Neon and Helium.* **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 175–178, Aug. 31, 1909.)—The author confirms the curious property of neon observed by Collie [Abstract No. 1429 (1909)]. The triple-point pressure of neon is found to be 35 cm. and the critical pressure 29 atmos. By strongly cooling liquid helium at low pressure a temperature estimated to lie below 2·5° abs. was attained. A first determination of the critical pressure of helium gives the value 2·75 atmos. T. H. P.

2085. *Laws of the Displacement of Equilibrium and the Principle of le Chatelier.* **C. Raveau.** (Soc. Franç. Phys., Bull. 1. pp. 58–61, 1909.)—Although the principle of le Chatelier may be a perfectly complete and accurate expression for the laws of the displacement of equilibrium, it is not unique and indispensable. There are other equivalent expressions for these laws which at first sight appear quite different. The author shows that starting from the stable state the isothermal compressibility is greater when some interior modification occurs than when no such modification occurs. In a stable isothermal transformation the variation of volume due solely to an interior modification is of the same sign as the total variation. At constant pressure the calorific capacity is greater when an internal modification occurs than when no such modification occurs. We can also say that in a stable transformation at constant pressure the quantity of heat evolved by the internal modification is of the same sign as the total transformation. A. R.

REFERENCES.

2086. *Measurement of Specific Heats by Means of a New Liquid Calorimeter.* **H. Schottky.** (Phys. Zeitschr. 10. pp. 634–639, Sept. 15, 1909.)—The author describes a new form of calorimeter containing pentane and surrounded by a vacuum-jacket, and the method of using it. The results are given of measurements of the specific heat and calculation of the molecular heat of the following substances: Hg_2SO_4 ; $BaCl_2$; $BaCl_2, H_2O$; $BaCl_2, 2H_2O$; K_4FeCy_6 ; $K_4FeCy_6, 3H_2O$; $ZnSO_4, 7H_2O$; PbF_2 ; $PbCl_2$; $PbBr_2$; PbI_2 ; $Na_2S_2O_3$, and $Na_2S_2O_3, 5H_2O$. T. H. P.

2087. *Some Consequences of employing a Selective Receiver in the Measurement of Radiation.* **C. Féry.** (Soc. Franç. Phys., Bull. 2. pp. 133–145, 1909.)—The full paper corresponding to Abstracts Nos. 861, 1071 (1909).

2088. *Proof of the Radiation Law in the Case of the Bunsen Flame.* **H. Schmidt.** (Ann. d. Physik, 29. 5. pp. 971–1028, Aug. 10, 1909.)—The full paper corresponding to Abstract No. 863 (1909).

2089. *Internal Pressure of Fluids and the Law of Intermolecular Attraction.* **E. H. Amagat.** (Journ. de Physique, 8. pp. 617–631, Sept., 1909. Paper read before the Soc. franç. de Physique.)—The full paper corresponding to Abstract No. 1252 (1909).

2090. *Noble Gases and the Equation of State.* **H. Happel.** (Ann. d. Physik, 30. 1. pp. 175–181, Aug. 31, 1909.)—The author criticises Rudorf's objections [Abstract No. 1568 (1909)] to his extended form of van der Waals' equation [Abstract No. 823 (1904)]. T. H. P.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

2091. *Electrodynamics.* **G. Nordström.** (Phys. Zeitschr. 10. pp. 681–687, Oct. 15, 1909.)—A highly analytical discussion of the electrodynamics of Minkowski. The kernel of this theory lies in the postulate that all electrodynamical phenomena follow unaltered laws, provided they are referred to different space-time systems of reference. Between the co-ordinates of the two systems linear relations hold. Time is here treated as one co-ordinate which is represented by Minkowski as $ct\sqrt{-1}$, where c is the speed of light, and t is the time itself. E. H. B.

2092. *Determination of e/m_0.* **K. Wolz.** (Ann. d. Physik, 30. 2. pp. 273–288, Oct. 14, 1909.)—Performing with great care experiments on the method of A. H. Bucherer [see Abstract No. 912 (1909)], the author finds as the mean value $e/m_0 = 1{\cdot}7674 \times 10^7$, the accuracy being $\pm 1{\cdot}5$ per thousand. The paper also contains a valuable summary of the various chief results obtained by previous workers, of which the following is the later part :—

Observer.	Date.	Rays.	Method.	e/m_0.
Seitz	1902	Kathode	Magnetic and electric deflection	$1{\cdot}87 \times 10^7$
W. Kaufmann	1902	Becquerel	Ditto	$1{\cdot}845 \times 10^7$
A. Wehnelt	1903	Incandescent electrolyte	Magnetic deflection and electrode voltage	$1{\cdot}4 \times 10^7$
A. Becker	1905	Kathode	Ditto	$1{\cdot}847 \times 10^7$
W. Kaufmann	1906	Becquerel	Magnetic and electric deflection	$1{\cdot}884 \times 10^7$
P. Weiss and A Cotton	1907	—	Zeeman-effect	$1{\cdot}767 \times 10^7$ (acc. to Gmelin)
A. Bestelmeyer	1907	Kathode	Magnetic and electric deflection	$1{\cdot}72 \times 10^7$
A. Stettenheimer	1907	—	Zeeman-effect	$1{\cdot}791 \times 10^7$ (acc. to Gmelin)
A. H. Bucherer	1908	Becquerel	Magnetic and electric deflection	$1{\cdot}763 \times 10^7$
J. Classen	1908	Incandescent electrolyte	Magnetic deflection and electrode voltage	$1{\cdot}776 \times 10^7$
P. Gmelin	1909	—	Zeeman-effect	$1{\cdot}771 \times 10^7$

E. H. B.

2093. *Observations of Electrical Dissipation.* **C. Negro.** (Phys. Zeitschr. 10. pp. 449–453, July 1, 1909. Translation.)—The observations were made in Aug., 1908, at Moncalieri, near Turin, and in Sept., 1908, 8 km. from Bologna. The monthly mean values were high, Aug. $a_- = 3{\cdot}31$, $a_+ = 3{\cdot}25$, $q = 1{\cdot}00$; Sept. $a_- = 3{\cdot}93$, $a_+ = 4{\cdot}05$, $q = 0{\cdot}98$. The results are summarised as follows : (1) On days of clear sky the diurnal variation is regular ; it has a maximum in the afternoon and a minimum early in the morning ; positive dissipation is in excess. (2) Overcast and half-overcast days in Sept. showed higher dissipation than days of clear sky. In Aug. only a_- was higher for half-overcast days ; on overcast days dissipation was smaller than on days of clear sky. (3) The secondary minimum about midday was not found. (4) On days of thunderstorm the values were very irregular, at times a_+ was markedly variable, at others this was the case with a_-. (5) Valley fogs caused great decrease both of negative and positive ionisation. R. G. K. L.

2094. *The Air-earth Current and Variations of Potential Gradient near the Surface.* **D. Smirnov.** (Phys. Zeitschr. 10. pp. 445–449, July 1, 1909. Physikal. Zentral Observatorium, St. Petersburg.)—Variations in the air-earth current, due to the interposition of a layer of different conductivity may have important influence on the potential gradient. The cooling of the surface after sunset causes the formation near the surface of a thin layer of high humidity which the ions penetrate with difficulty, and thus a massing of positive ions takes place in this layer, above which the intensity will decrease. Experiments with a parallel plate condenser are described to illustrate the variation of potential on the Eiffel Tower and at the surface. The lower negatively charged plate represents the earth's surface, and the upper one the positively charged atmosphere. Through a hole in the lower plate is passed the knob of an electroscope, representing the tower. A glass disc to which a weak positive charge is given is placed between the plates; it has a hole in it, so that it can be lowered over the knob. With this model, a deflection of 30 was obtained when the disc was above the knob, a deflection of 32 with the disc at the level of the knob, while with the disc near the lower plate of the condenser the deflection was only 22. The rise of potential on the tower during the day is explained by convection currents which cause an accumulation of excess of positive ions (represented in the model by the glass disc) above the tower. Towards evening convection currents cease and the positive ions have free access to the earth. The max. potential corresponding to the position of the disc at the level of the knob occurs on the tower earlier than near the surface. The fall of potential during the day near the surface, which is not shown in the tower, is illustrated by placing near the lower plate a negatively charged glass disc, representing the negative charge in the lower atmosphere due to dust, &c. Towards evening this is neutralised by the descent of the positive charges. An experiment made at Pavlovsk on Oct. 25, 1908, with an Ebert apparatus placed quite near the ground to test for the increase of positive ions as the sun's influence is withdrawn gave a value for $Q_+ - Q_-$ of 0·30 while the sun was shining, and of 0·78 when the ground was in shadow. The results are not regarded as conclusive, as some of the positive ions are converted into heavy Langevin ions and are not caught by the apparatus. The author then proceeds to apply the suggestion to explain the results recently obtained by A. Daunderer [Abstract No. 669 (1909)]. R. G. K. L.

DISCHARGE AND OSCILLATIONS.

2095. *Kinetic Energy of the Ions emitted by Hot Bodies.* **O. W. Richardson.** (Phil. Mag. 18. pp. 681–695, Nov., 1909.)—In experiments previously described [Abstract No. 678 (1909)] the apparatus was not suitable in some respects, and further experiments have been carried out with a new apparatus involving the same principles, but made larger, and constructed so as to satisfy accurately the geometrical conditions laid down by the theory. This theory has been subjected to a more exact test, and it has been confirmed in a satisfactory way, but only under certain rather restricted conditions. Under certain other conditions the curves obtained were not at all what was expected, but the discrepancy is considered to be due to causes lying outside the theory under consideration. The results of the experiments are shown on a curve which exhibits a very close agreement between the distribution of the electrons from a hot Pt strip, in the absence of an external electric field, as found experimentally, and that which was predicted in the former paper on the hypothesis that the electrons emitted from the strip left it with a distribution of velocity equivalent to that required by Maxwell's law. J. J. S.

2096. *Negative Ions from Reacting Metals.* **F. Haber and G. Just.** (Ann. d. Physik, 30. 2. pp. 411–415, Oct. 14, 1909. From the Physikal. Chem. und Elektrochem. Laborat. d. techn. Hochschule "Fredericiana," Karlsruhe.) —This paper contains an account of some experiments carried out with sodium-potassium alloy, sodium, and lithium amalgam. The object in each case is to ascertain whether any electrons are given off during the process of coating the surfaces of the above substances with oxide or hydroxide. It is found that the "reaction effect" in these cases is very similar to the photoelectric effect. The most important difference between these two effects lies in the fact that in the reaction effect, unless the electrons generated are helped, either by an electric field or an air current, they do not leave the zone of action in sufficient numbers either to cause the substance to become positively charged or to charge up negatively a suitably placed electrode. In other words, their initial velocity is very small compared with that of the electrons due to the photoelectric effect. The similarity of the two effects appears more clearly if we consider the photoelectric effect as due to explosion brought about by vibrations in resonance, and the reaction effect as an explosion due to chemical reaction. Further researches are to be carried out, but these preliminary results make it appear that the order in which the common metals must be placed with respect to this property is the same as that given by Elster and Geitel for their photoelectric effect. A. E. G.

2097. *Photoelectric Effect with the Alkali Metals.* II. **F. K. Richtmyer.** (Phys. Rev. 29. pp. 404–408, Oct., 1909.)—In a previous paper [Abstract No. 1579 (1909)] the author has shown that the photoelectric current from a sodium surface under the action of light from an incandescent lamp is proportional to the intensity of the incident light for very low intensities up to intensities of 0·5 candle-ft. In view of the fact that some observers have found that this linear relation does not exist if very great ranges of intensities are used, the present experiments are undertaken in order to extend the observations with higher light-intensities. The method of arranging the apparatus is clearly explained. From the results obtained it seems evident that the linear relation between the photoelectric current and the intensity of illumination holds, even for intensities up to 620 candle-ft. Although great difficulties are experienced in controlling the light source, the plotted results do not deviate to any extent from a straight line, and even up to the highest intensities there is not the slightest suggestion of saturation. A. E. G.

2098. *Constitution of Electric Radiations.* **T. Levi-Civita.** (N. Cimento, 18. pp. 168–169, Sept., 1909. Communicated to the Padua Congress of the Italian Physical Society, Sept., 1909.)—The projection of the β-rays of radium may be regarded either as a stream of discrete particles sufficiently far apart to make their mutual influence negligible, or as a practically continuous fluid. The author calls the former the "ballistic" and the latter the "hydraulic" view. It is possible to distinguish between the two views by experiment. Under the ballistic condition the magnetic deviation is independent of the intensity of the current, while under the hydraulic condition the deviation should be inversely proportional to the electric flux or current intensity.

The author inclines theoretically to the hydraulic view, which would harmonise with his "asymptotic" theory of electric radiation. [See also **M. Abraham**, ibid. p. 200, Sept., 1909.] E. E. F.

2099. *Magnetic Rays.* **A. Righi.** (Accad. Lincei, Atti, 18. pp. 241–246, Oct. 17, 1909.)—By a new mathematical treatment of the orbit of an electron round a moving positive ion in a magnetic field [see Abstract No. 674 (1909)], the author shows that the orbit is similar to that which accounts for the Zeeman-effect, and that the presence of the magnetic field has the effect of imparting an increased stability to suitably oriented electronic orbits, such as are supposed to constitute magnetic rays. E. E. F.

2100. *Positive Rays.* **W. Wien.** (K. Bayer. Akad. München, Sitz. Ber. July 3, 1909. Ann. d. Physik, 30. 2. pp. 349–368, Oct. 14, 1909.)—The author gives an account of further researches [see Abstract No. 268 (1909)], and describes his observations on the positive rays of hydrogen, air, and mercury. The influence of magnetic fields at various pressures and various potentials on the positive rays of hydrogen, as well as the heat action and brightness at different pressures, were investigated. The chief results of the observations are as follows: (1) The positive rays of hydrogen produced under similar conditions are at high rarefactions less strongly influenced magnetically than at lower. (2) The rays which are weakened by a magnetic field will also be weakened in their heat action and light emission by a second magnetic field nearly in the same proportion as those rays on which the first magnetic field has not acted. (3) The light emission is under otherwise similar conditions considerably less with high rarefactions than with low, both in the case of hydrogen and air. (4) The magnetic influence is not noticeably dependent on the potential, neither at high nor low gas pressure. (5) The canal rays of mercury carry no noticeable positive charge, and a deflection is not detected in strong magnetic fields through direct observation of the light emission. From the results of the observations it appears to the author that the positive atoms tend to the neutral condition as that of stable equilibrium. If occasion for new formation is absent they will be neutralised by existing electrons. The experiments with different rarefactions show that at higher gas pressures stronger magnetic influence comes in and more positively charged atoms are present. The formation of positive atoms is probably due to collisions with resting gas molecules. With a definite degree of rarefaction a stationary condition is set up, when as many positive atoms are re-formed as are neutralised. At very high rarefactions the number of collisions is small and only few new positive ions are formed. In mercury vapour the neutralisation of the positive atoms will be favoured by the presence of very large numbers of electrons, which explains why generally no positive atoms are observable. The fact that notwithstanding this the mercury rays glow makes it probable that the glow occurs in the neutral condition. J. J. S.

2101. *Observations of W. Wien on the Positive Charge of Canal Rays.* **J. Stark.** (Phys. Zeitschr. 10. pp. 752–756, Nov. 1, 1909. Physikal. Inst. d. techn. Hochschule, Aachen, Sept., 1909.)—W. Wien has put forward the assertion that the carriers responsible for line spectra are neutral atoms and that the result is brought about by the recombination of the negative electrons with the positive "remainder atom." Stark, on the other hand, has shown, in connection with the Doppler-effect with canal rays, that the carriers in the case of line spectra are positively charged atom ions, and in relation to band spectra he has put forward the hypothesis that the carriers are neutral atoms or molecules, and that the spectra are emitted as the result of recombination of totally or partially separated negative electrons with the positive remainder atom [see Abstracts Nos. 57 (1907), 1087 (1908)]. The present paper investigates the experimental conditions of Wien's work, in particular whether the current going to earth through a receiver and galvanometer is identical with the quantity of the electricity which in unit time enters the opening of the receiver in the form of rays. The conclusion arrived at is that, in the observations of Wien that hypothetical identity is not merely quantitatively false, but even the sign of the sought effect may be changed. Full explanations for this conclusion are given, together with a criticism of Wien's experiments. Experiments are also described which show that Wien has no strong basis of support for his assertion that the canal rays in mercury transport no marked positive charge. It is then shown experimentally that these rays do carry a positive charge. **W. Wien.** (Ibid. p. 862, Nov. 10, 1909.)—Wien maintains his position. A. E. G.

2102. *Photoelectric Phenomenon in Dielectric Liquids.* **A. Naccari.** (Accad. Sci. Torino, Atti, 44. 12. pp. 894–897, 1908–1909.)—The author describes investigations on the influence of light on the resistance of the dielectric liquid toluene. In a circular glass basin was placed a disc of nickeled copper, above which, at a height of about 1·5 mm., was supported a disc of brass gauze. The two discs were connected through a galvanometer with the poles of a battery of 53 Leclanché cells. Diffused light has no influence on the direction of the current, but causes a marked increase in its magnitude. Direct sunlight has a similar effect, which is diminished considerably by interposing a solution of copper sulphate or potassium dichromate. Light from a Uviol lamp also causes marked decrease in the resistance of toluene, but that from an Auer lamp has little effect. The resistance of petroleum is also diminished by the action of light, though to a far less extent than that of toluene, whilst with aniline or alcohol no such change is observed. T. H. P.

2103. *Photoelectric Effect of Sodium-Potassium Alloy and its Bearing on the Structure of the Ether.* **J. Kunz.** (Phys. Rev. 29. pp. 212–228, Sept., 1909.)—This subject is first considered from a theoretical standpoint, and a result obtained which indicates that the velocity of the electrons should be proportional to the frequency of the incident light, while according to Planck's theory the velocity obtained would be proportional to the square root of the frequency of the incident light. Experimental details are next described. It is found that the p.d. obtained is constant and independent of the intensity of the light, being always 1·12 volts, unless the intensity of the light falls below a certain value, in which case the p.d. becomes decidedly smaller. The p.d. obtained appears to be proportional to the wave-length and decreases with increasing wave-length; deflections calculated on this basis differ only about 2 per cent. from those observed. This law appears to hold good only to wave-lengths of about 520 μμ. From this point to a wave-length of 582 μμ the connection between the potential of the alloy and the wave-length is almost a straight line. Beyond this point the deflection becomes small very rapidly, and irregular at the same time. So far as these preliminary experiments go they seem to indicate that the velocity of the electrons is independent of the intensity of the light and that the kinetic energy is proportional to the frequency of the incident light. The velocity of the electrons emitted under the action of violet light of wave-length 420 $\mu\mu$ is found to be $6{\cdot}8 \times 10^7$ cm. per sec. It is proposed to extend the research [see also Abstract No. 1782 (1909).] A. E. G.

2104. *Absorption of Gases by the Anode in a Glow Discharge.* **V. L. Chrisler.** (Phys. Rev. 29. pp. 461–477, Nov., 1909. Phys. Zeitschr. 10. pp. 745–752, Nov. 1, 1909.)—The object of this research is to measure directly the velocity of the absorption of different gases by the anode. The plan adopted is to use as kathode a substance which has been previously freed as far as possible from contained gas, so that it can contribute in no marked degree to any pressure alteration. By this means the alteration in gas pressure gives at once a measure of the absorption due to the anode. When silver is used for anode, hydrogen is absorbed for 2 to 4 min. with the calculated velocity, and then absorption suddenly ceases. It is probable that when the metal surface is saturated with the gas the absorption ceases, or, as Skinner has pointed out, uncharged gas from the metal escapes just as quickly as the charged gas enters. It is concluded that hydrogen is absorbed by sodium, by potassium, by sodium-potassium alloy, and by mercury, when these substances are used as anode in a glow discharge, in such masses that it follows that with every absorbed atom a negative charge of the same magnitude is associated, as the positive charge which it carries in solutions. The same proof is obtained for nitrogen when Na, K, and Na-K alloy are used as anode, as well as for helium when Na and Hg are used as anode. The helium atom must here be associated with a negative charge equal in magnitude to the positive charge carried by a hydrogen atom in solution. Full descriptions of the experiments are given, and the results are in all cases graphically represented. A. E. G.

2105. *Change of Spark Potential under the Influence of Radium.* **V. K. Lebedinskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 5. pp. 211–213 (Phys. Part), 1909.)—Further experiments on the action of radium and the ultra-violet light of the arc on a spark passing between a negatively charged sphere and a positively charged point [see Abstract No. 278 (1909)] lead to the conclusion that the ignition of the spark consists in diminishing the dielectric capacity of the insulator in which the spark passes, whilst extinction of the spark is due to increase of this dielectric capacity. Since both these actions are produced, in different degrees, by one and the same light, it is to be assumed that such light exerts two kinds of action on the electric condition of the insulator, these being possibly an ionising action and the pressure of light. T. H. P.

2106. *Anode Drop with Hot Lime Kathode.* **C. D. Child.** (Phys. Rev. 29. pp. 351–368, Oct., 1909.)—The drop in potential at the anode of the electric arc in a vacuum has been found to be much smaller than the corresponding drop in a vacuum with small currents and unstriated discharge. The value of the former is about 6 or 7 volts, while that of the latter is about 20 volts. The discharge from hot lime (CaO) in a vacuum is in some respects intermediate between these two kinds of discharge, and the author has examined the potential drops with intermediate currents. The anode drop was examined with the luminous discharge produced by hot CaO when the pressures of the gas were low. It varies greatly as the distance between the anode and the kathode is varied, being greatest when they are near together and least when a few cm. apart. The anode drop is large both with small and large currents. The amount of current corresponding to the minimum anode drop depends on the pressure of the gas and the distance between the drop electrodes. With gas pressures of about 1 mm. or more the anode is approximately independent of the current and of the distance between the electrodes, and increases slightly as the pressure of the gas increases. In hydrogen it is approximately the same as in air. It is the same for Fe and Hg anodes, but an Al anode gives a higher value. With currents of about half an ampere there was a concentration of glow on one spot on the anode and a decrease of the anode drop. The discharge in this case appears to have all the characteristics of an arc. The phenomena can be explained by assuming that at low pressures and with small currents the anode drop depends on the velocity of the negative ions at the anode; that with higher pressures it depends on the p.d. required to produce positive ions at the surface of the anode, and that with larger currents this ionisation p.d. is modified by the concentration of current at one spot. A. R.

2107. *Destructive Effects produced by a High-frequency Oscillating Discharge.* **A. Léauté.** (Comptes Rendus, 149. pp. 849–851, Nov. 15, 1909.)—Violle has shown that when a thin wire is stretched on a plate of glass and is deflagrated by means of a discharge from the secondary of an induction coil the trace left on the glass is interesting. There is a fine central ray and at right angles to it are regularly spaced parallel rays very close together. This experiment led the author to study the effects produced by high-frequency discharges. He uses a condenser and an inductive coil. He finds that the greater the energy of the discharge the greater the trace left on the glass, and that self-inductance of the circuit of the discharge plays an important *rôle* in the phenomenon. For example, when working with a capacity of 0·02 mfd. an explosive voltage of 25,000 and a brass wire 0·06 mm. in diam., he finds that an inductance of 2 microhenrys only appreciably alters the trace and that an inductance of 100 microhenrys suppresses it altogether. He deduces from his experiments that the cause of the peculiar appearance of the trace is the actual explosion of the wire by the discharge. The particles of metal are vaporised and violently projected perpendicularly to the wire and thus produce the fine striations on the plate. Séménov's hypothesis that the path of the fire in the electric spark produces an explosion of the molecules of the air along its path, supports this conclusion. Very sudden discharges can produce very destructive effects although the energy is small. This explains the difficulty of protecting aerial electric lines from damage by lightning. The question remains to be discussed whether the destructive effects produced by diminishing the self-inductance of the line are due to the increase in the amplitude of the maximum current or to the diminution of the period of the oscillation. The author will show shortly how this question can be answered by calculation. A. R.

2108. *Musical Arc Oscillation in Coupled Circuits.* **E. T. Jones** and **M. Owen.** (Phil. Mag. 18. pp. 713–722, Nov., 1909.)—Jones, in a previous paper [see Abstract No. 527 (1909)] has shown that if the primary of a pair of coupled circuits, in series with a condenser, forms the shunt to a Duddell musical arc, and if the secondary musical coil is connected with another condenser, either of two notes may, under certain circumstances, be heard. It was also shown that the frequencies of the electrical oscillations of the circuits corresponding to the two notes are generally much lower than those calculated for the two circuits from the inductances of the coils and the capacities of the condensers, the resistances being neglected. In the present paper the influence of the resistances of the circuits is considered. The authors conclude that the great differences between the observed frequencies of the electrical oscillations in coupled circuits produced by the musical arc and the values calculated from the inductances of the coils and the capacities of the condensers, cannot be accounted for merely by allowing for the resistances of the circuits. The principal cause of this difference is that the arc behaves as if it had self-inductance, which is constant during any particular train of oscillations (though different under different circumstances), and this has to be taken into account when calculating the frequencies. Any one of the harmonics of the arc note up to the sixth can be strongly reinforced by suitably adjusting the ratio of the two frequencies of the system. If the notes of the arc are equally stable, and if the interval between them is a perfect fifth, a third note may be heard which corresponds to an electrical oscillation of frequency equal to the difference of the frequencies of the two primes. A. R.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2109. *Optical Constants of Certain Solid Metallic Solutions.* **A. L. Bernoulli.** (Zeitschr. Elektrochem. 15. pp. 646–648, Sept. 1, 1909. Paper read before the 16. Hauptversamml. d. Deutsch. Bunsen-Gesell., Aachen, May, 1909.)—The fact that alloys possess a much lower electrical conductivity than pure metals may be due either to the number of free conducting electrons being diminished or to the internal friction of the electrons being increased, as is the case in gaseous mixtures [compare Abstract No. 1050 (1907)]. The number of free conducting electrons can be calculated from the optical constants. The author gives the results of measurements of the indices of absorption and refraction for a number of alloys of silver, copper, and cadmium [see Abstract No. 1394 (1909)]. It is found that the number of electrons per c.cm. is not diminished, but rather somewhat increased, by alloying with another metal. The increased resistance of alloys is hence not to be explained by diminution of the number of electrons. T. H. P.

2110. *Deviations from the Law of Wiedemann and Franz in the case of Solid Metallic Solutions.* **R. Schenck.** (Zeitschr. Elektrochem. 15. pp. 648–652, Sept. 1, 1909. Paper read before the 16. Hauptversamml. d. Deutsch. Bunsen-Gesell., Aachen, May, 1909.)—The kinetic electron theory gives for pure metals the relation, $k/\sigma = 4(a/e)^2 T/3$, where a is the temperature coefficient of the kinetic energy, e the electric charge of a particle, T the absolute temperature, and k and σ the thermal and electrical conductivities respectively [see Abstract No. 1050 (1907)]. With alloys, in so far as they form solid solutions, the dissolved molecules, as well as the electrons, are to be regarded as carriers of the kinetic energy. The value of the ratio k/σ must therefore increase with the concentration of the dissolved molecules, so that $a = ia$, i being the ratio of the sum of electrons and dissolved molecules to electrons. Experiments made by Hardebeck to determine the ratio k/σ for dilute solid solutions of Ag-Tl, Ag-Sn, Cu-Ni, Cu-Sn, Cu-Zn and Hg-Cd by Kohlrausch's method confirm these conclusions [compare Bernoulli, preceding Abstract]. The degree of dissociation p of the metal, that is, the number of free electrons per atom of metal, is for silver 0·5, for cadmium 2·5–3 and for copper 1. T. H. P.

2111. *Mutual Induction of Two Rectangles.* **F. F. Martens.** (Ann. d. Physik, 29. 5. pp. 959–970, Aug. 10, 1909. Phys. Inst. d. Handelshochschule, Berlin, June, 1909.)—The author first works out a general expression for the mutual induction of two thin straight conductor elements situated in any arbitrary manner with respect to each other. The expression is a rather lengthy one of three terms. For two lengths each $2p$ at a distance h cm. it reduces to—

$$L = 2\left\{2p \log_e \frac{2p + \sqrt{h^2 + 4p^2}}{h} + h - \sqrt{h^2 + 4p^2}\right\}$$

and when h becomes very small in comparison with p, the expression becomes $L = 4p\left(\log_e \frac{4p}{h} - 1\right)$. The formulæ obtained have the advantage of being closed, which cannot be claimed for circular currents even when parallel and coaxial. The mutual induction of two rectangles of sides $2p$ and $2q$ respectively, lying in the same plane, and symmetrically to each other, is—

$$L = 8\left\{h \log_e \frac{h + \sqrt{h^2 + H^2}}{H} + H \log_e \frac{H + \sqrt{h^2 + H^2}}{h}\right.$$
$$\left. - 2\sqrt{h^2 + H_2} + (H + h)\left\{\sqrt{2} - \log_e (1 + \sqrt{2})]\right\}\right\},$$

where $h = p - q$ and $H = p + q$. This formula may be used for constructing an absolute ammeter for alternating currents. A general expression for arbitrarily situated rectangles is also given, and a formula for change of L with mutual inclination, with numerical examples. E. E. F.

2112. *Effect of Mechanical Shocks upon the Residual Charges of Condensers.* **P. L. Mercanton.** (Comptes Rendus, 149. pp. 591–593, Oct. 11, 1909.)—A description of the apparatus used is given, and a table of the results obtained. The observations, while not being of such a nature as to enable one to deny the existence of any action due to shocks, yet make it clear that this influence, if it exists, is incomparably more feeble than that which they exercise upon the magnetic state of the ferromagnetic substances. Care was taken to avoid a possible effect of daylight upon the conductivity of the dielectric, and also to avoid temperature variations. A. E. G.

2113. *Standard Air Condensers and their Absolute Measurement.* **E. Giebe.** (Zeitschr. Instrumentenk. 29. pp. 269–279, Sept., and pp. 301–315, Oct., 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—An account of the measurement, by Maxwell's method, of the capacity of cylindrical- and parallel-plate air condensers. The speed of the driving motor was regulated by a special centrifugal governor [see Abstract No. 1768 (1909)] and to this regulation much of the consistency in the results obtained is doubtless due. As an example, it is of interest to note that 5 consecutive values obtained for a 0·01 mfd. condenser in no case differ from the mean value by more than 10 parts in a million. Those interested in the subject of the absolute measurement of capacity should consult the original paper for details of the construction of the condensers, commutator, &c. F. E. S.

2114. *Standard Resistance with Balanced Inductance and Capacity.* **S. L. Brown.** (Phys. Rev. 29. pp. 369–391, Oct., 1909.)—Resistance coils which are measurably free from inductance and capacity have been made by the author in the form of two long parallel wires joined at one end and separated to such a distance that the inductance and distributed capacity balance. These coils were used as standards and compared with other commercial coils by means of a Wheatstone network. The residual capacity of these latter coils was of the order of 1,000 micro-microfarads when the coils were of 1,000 ohms resistance. A so-called "ideal coil" as constructed by Taylor and Williams [see Abstract No. 1477 (1908)] was also made, and comparisons showed it to have a considerable excess of capacity over inductance. [This result agrees with previous observations made by Brown, Abstract No. 285 (1909).] F. E. S.

ALTERNATING CURRENTS AND MAGNETISM.

2115. *Improved Semicircular Electromagnet.* **H. E. J. G. du Bois.** (Konink. Akad. Wetensch. Amsterdam, Proc. 12. pp. 189–192, Oct. 28, 1909.)—An instrument which has been developed from the author's large electromagnet designed in 1894; it has polar coils, or coils round the pole-shoes, for obtaining the highest degree of magnetisation, and it is comparatively light in weight for its power. It is designed chiefly for use in magneto-optical investigations. Fields of nearly 50 kilogauss were obtained with windings of 124 kilo-ampere turns and using extra polar coils. The weight of the apparatus is under 300 kg. A smaller magnet of the same type, but weighing only 83 kg., gave 37 kilogauss with 24 kilo-ampere turns. The pole space in both cases was 0·5 mm. G. E. A.

2116. *Effect of Previous Magnetic History on Magnetisation.* **E. Wilson, G. F. O'Dell,** and **H. W. K. Jennings.** (Roy. Soc., Proc. Ser. A. 83. pp. 1–9, Nov. 8, 1909.)—Hysteresis loops for Stalloy and Lohys iron rings were obtained in three conditions: (1) By a cyclic variation of magnetising force H between $+H_1$, and $-H_1$ on a carefully demagnetised specimen. (2) H was now increased to $+H_2$ $(H_2 > H_1)$, reversed 50 times, and reduced from $+H_2$ to 0. A loop was again plotted for a cyclic variation of H between $+H_1$, and $-H_1$ after many such cyclic reversals. (3) The iron was now demagnetised, and a constant field H_3 applied such that on superposing a cyclic variation of H between $+H_1$ and $-H_1$ the change of induction was, after many reversals, the same as in (2). The change from loop (1) to loop (2) is due to intermolecular forces, and that from (1) to (3) to an external force H_3. As the area of loop (2) is never less than, and usually considerably exceeds the area of loop (3), the conclusion is arrived at that iron may be in one or other of two states according to treatment, the same change of magnetic induction being produced in each by the same change in magnetic force, but the energy expended in the change being different. Some experiments are also described showing that certain effects due to magnetic viscosity are greater in solid than in laminated specimens.

A. D. R.

2117. *Magnetic Properties of Iron and Manganese Alloys.* **C. F. Burgess** and **J. Aston.** (Electrochem. Ind., N.Y. 7. pp. 476–478, Nov., 1909.)—Gives results of experiments on the effect of manganese on the magnetic properties of steels. The magnetic tests were made upon an Esterline permeameter, under four conditions of heat treatment, viz., as forged, after annealing at 675° C., after annealing at 1,000° C., and after quenching at 900° C. and all results are compared to a standard bar of forged electrolytic iron in its unannealed state. In the unannealed state the alloys show a successive deterioration in permeability with increasing Mn-content until at 10·42 per cent. Mn the bar is non-magnetic. Annealing at 675° resulted in a marked betterment of magnetic quality for all the bars. The second annealing at 1,000°, caused a considerable decrease of permeability of all the bars and practically brought them back to the same condition as when raw forged. The only important feature brought out by quenching tests was a great improvement in the bar containing 4·51 per cent. Mn which was restored to its best condition as obtained after the first annealing at 675°. The values of coercive force and retentivity follow closely the fluctuations indicated above. The retentivities increase as a result of annealing at 675°, decrease on annealing at 1,000° and again increase on quenching from 900°. The coercive force for a bar containing 0·5 per cent. Mn becomes less with each annealing and there is little change on quenching, but for the other bars the values decrease on annealing at 675°, increase after heating to 1,000° and again become less on quenching at 900°. The authors suggest that in steels for electrical work, where, in general, strength is of secondary consideration, sulphur should be kept low and silicon additions be made instead of manganese as a deoxidiser. Judicious annealing at low temperatures may greatly benefit material which would otherwise be condemned, while overheating may spoil a good material. [See Abstract No. 2138 (1909).] C. O. B.

2118. *Magnetic Storm of September* 25, 1909. **E. Marchand.** (Comptes Rendus, 149. pp. 616–619, Oct. 11, 1909.)—A comparison of the magnetic observations made on the Pic du Midi and at Bagnères-de-Bigorre show a general similarity, but the somewhat greater disturbance at the high-level station seems to indicate that the currents perturbing the earth's magnetic field pass chiefly through the atmosphere. Notes are given of an aurora observed at Bagnères and of a violent storm which occurred in the Pyrenees at the time of the disturbance, and in the midst of a period of fine and calm weather. The magnetic disturbances of Sept. 22–26 are divided into three groups, which are shown to correspond closely with the transit of three groups of sun-spots and faculæ over the central meridian of the solar disc. A. D. R.

2119. *Solar Origin of Magnetic Storms.* **J. Bosler.** (Comptes Rendus, 149. pp. 722–724, Nov. 2, 1909.)—It is shown that terrestrial magnetic storms can be fully accounted for by electric charges leaving the sun, even if energy is so radiated at only $\frac{1}{100}$ of the rate of thermal radiation. Further, the magnitude of the magnetic fields in sun-spots leads on this theory to a very probable value for the density of electrons in the chromosphere. A. D. R.

REFERENCES.

2120. ***Discharge Potentials with Alternating Currents: Influence of the Curvature of the Electrodes.*** **J. de Kowalski and U. J. Rappel.** **(Phil. Mag. 18. pp. 699–712, Nov., 1909.)—[See Abstract No. 1593 (1909).]**

2121. *Electronic Orbits.* **A. Garbasso.** (Accad. Lincei, Atti, 18. pp. 583–589, June 5, 1909.)—Works out the motion of a perturbed electron, whose elliptic orbit has a movement of rotation (Stoney, R. Dublin Soc., Trans. 4, 1891, p. 563), and describes a machine for tracing such orbits. E. E. F.

2122. *Hydrodynamical Analogy of Bjerknes to Electrical Phenomena.* **H. Witte.** (Ann. d. Physik, 30. 2. pp. 337–348, Oct. 14, 1909.)—A mathematical discussion of the application made by V. Bjerknes of the pulsating spheres to the elucidation of electromagnetic phenomena. E. H. B.

2123. *Electromagnetic Mechanics.* **M. Abraham.** (Phys. Zeitschr. 10. pp. 737–741, Nov. 1, 1909.)—G. Nordström called attention to certain differences between the electrodynamics of moving bodies due to Minkowski and that developed by the present author, who here discusses mathematically the points in question, using vector analysis of four-dimensional space. [See Abstracts Nos. 1990 (1908) and 2091 (1909).] E. H. B.

2124. *Influence of the Breaking of the Current in one Circuit on another Closed or Open Circuit.* **N. Bulgakov.** (Acad. Sci. St. Pétersbourg, Bull. 9. pp. 603–622, May 15, 1909.)—A mathematical paper, in which the author considers the influence of breaking the current in one circuit on (1) the variation of the intensity of the induced current in a neighbouring closed circuit, and (2) the electric oscillations induced in the second circuit. A differential equation is obtained which expresses the current in the second circuit, and which can be integrated with the help of definite integrals. T. H. P.

2125. *Magnetic Field of a Coil.* **N. Stoyanoff.** (Phys. Zeitschr. 10. pp. 430–438, July 1, 1909.)—The strength of the magnetic field along the axis of a cylindrical coil of wire was determined and the results obtained were applied to determine the electromagnetic rotation of the plane of polarisation of light in certain liquids and to the measurement of Verdet's constant. The liquids dealt with were carbon bisulphide, benzene, and nitrobenzene. J. J. S.

2126. *Electromagnetic Induction.* **F. Emde.** (Elektrotechnik u. Maschinenbau, 27. pp. 783–790, Aug. 22, 1909.)—A mathematical article dealing with the fundamental ideas of the above subject.

2127. *Concerning Position of South Magnetic Pole.* **C. Chree, W. van Bemmelen.** (Terrestrial Magnetism, 14. pp. 85–86, June, 1909.)—Polemical.

2128. *Production of High-voltage Direct Current for Radiologic Purposes.* **M. Hochstädter.** (Elektrotechnik u. Maschinenbau, 27. pp. 563–568, June 13, and pp. 586–589, June 20, 1909.)—A detailed description of the commutating apparatus devised by H. C. Snook, with results of some experiments on animals with the high-frequency currents therewith produced. L. H. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2129. *Action of Radium Emanation upon Elements of the Carbon Group.* **W. Ramsay and F. L. Usher.** (Ber. Deut. Chem. Gesell. 42. pp. 2930–2931, 1909. Chem. News, 100. p. 209, Oct. 29, 1909.)—A continuation of the investigations referred to in Abstracts Nos. 1628, 1634 (1909). Solutions of various compounds of carbon-group elements were subjected to the action of about 0·1 c.cm. of radium emanation for four weeks. Carbon dioxide was produced in every case, and CO in the cases of Ti, Zr, and Pb. The following table gives the amount of carbon produced by 1 mm.^{3} of emanation :—

Solution of—		Carbon (mgm.).
H_2SiF_6		0·518
$Ti(SO_4)_2$		0·982
$Zr(NO_3)_4$	I.	1·071
	II.	0·878
$Th(NO_3)_4$	I.	2·98
	II.	0·968
$Pb(ClO_3)_2$		0·102

Mercurous nitrate gave no trace of CO_2 or CO. Lead appears to be specially stable, but otherwise it looks as if the elements of higher atomic weight were more inclined to split up than the lower ones. E. E. F.

2130. *Brownian Movement and Molecular Constants.* **J. Perrin and Dabrowski.** (Comptes Rendus, 149. pp. 477–479, Sept. 6, 1909.)—From observations with mastic and gamboge the authors find the mean value $N \times 10^{-22} = 70{\cdot}75$, where N is the number of molecules in a gm.-molecule [compare Abstracts Nos. 1816 (1908), 497 (1909)]. The most probable value of the charge of an electron is $4{\cdot}1 \times 10^{-10}$ electrostatic unit. The results obtained are in agreement with Einstein's formula. [See also next Abstract.]
T. H. P.

2131. *Brownian Motion of Rotation.* **J. Perrin.** (Comptes Rendus, 149. pp. 549–551, Sept. 27, 1909.)—According to Einstein's theory [Abstract No. 743 (1906)], the energy of rotation of a Brownian particle must be the same as its mean energy of translation. A spherical grain of radius *a*, placed in a liquid of viscosity *z*, and of absolute temperature T, must satisfy the equation—

$$\alpha^2 = \tau \frac{RT}{N} \frac{1}{4\pi z a^3},$$

where N is Avogadro's number and α^2 is the mean square of the rotation in an interval τ. In order to be able to observe the rotations microscopically it is necessary to make the grains larger than usual. The difficulty of agglutination (coagulation) is got rid of by using a 27 per cent. solution of urea in which to suspend globules of mastic, precipitated very slowly from alcoholic solution by allowing water to enter gradually through a fine orifice. Spheres of diameter 0·013 mm. are thus obtained, which travel 0·0023 mm. per min.

The rotations are observed by means of slight surface markings. The results give $\sqrt{\bar{a}^2} = 14°$. If $N = 65 \times 10^{22}$, Einstein's theory gives 14° 30′. The agreement is satisfactory. E. E. F.

2132. *Radio-active Elements and Inactive Gases.* **F. H. Loring.** (Chem. News, 100. pp. 37–39, July 23, 1909.)—The author draws a curve on a logarithmic scale with the atomic weights as ordinates. The inactive gases then describe a curve, which becomes a straight line at the higher weights and passes through a point at 175, which probably represents radium emanation. The atomic weights of He, (a), Ne, A, Kr, Xe, and Y are at logarithms 2, 3, 4, 5, 6, 7, and 8 respectively. The highest points 215 and 250 probably represent thorium emanation and actinium emanation respectively. Actinium ("Y") itself would have an atomic weight about 260. In the series UrX 235, Ur 239, AcEm 251, Ac 267, the differences are 4, 12, and 16, and the differences between these again are 8 and 4. A similar series is Hg 200, Tl 204, ThEm 216, Th 232. In the series Ra 224·97 (instead of 226), RaEm 174·97, I 126·97, Kr 82·97, the secondary differences are 2 and 4, whereas in the series Ag 107·9, Br 79·9, Fe 55·9, and A 39·9 they are 4 and 8. The product of lowest atomic weight is specially stable in each series. E. E. F.

2133. *Relation between Atomic Volume and Atomic Weight.* **J. Traube.** (Phys. Zeitschr. 10. pp. 667–670, Oct. 1, 1909.)—According to Bragg, the stopping power of metals and gases for α-rays is roughly proportional to the square root of the atomic weight of the metal, or the sum of the square roots of the atoms constituting the gaseous molecule. This same stopping power is also proportional to the molecular volume of the gases or vapours at their boiling-point. These two relations give a third relation between atomic weight and atomic volume. The author has calculated for a large number of organic compounds the quantity $\sqrt{\Sigma A}$, where A is the atomic weight of the constituent atoms, and compared it with the molecular volume v_0 at absolute zero as calculated by Guldberg in 1900. He finds $v_0 = 2{\cdot}6\sqrt{\Sigma A}$. The coefficient varies from 2·1 to 3·8 in the 64 compounds enumerated. Since valency is proportional to volume, there is a relation between the max. valencies N in the molecule and ΣA, which the author puts as $N = 1{\cdot}1\sqrt{\Sigma A}$. In the 87 substances enumerated the coefficient varies from 1·00 to 1·33.

E. E. F.

2134. *Resistance Furnaces with Electrically Heated Nickel Wire.* **M. Le Blanc.** (Zeitschr. Elektrochem. 15. pp. 683–685; Discussion, pp. 685–687, Sept. 15, 1909. Paper read before the 16. Hauptversamml. d. Deutsch. Bunsen-Gesell., Aachen, May, 1909.)—In order to lessen the cost of resistance furnaces, the author replaces the platinum by nickel wire (2 mm. thickness). In a porcelain tube of 4 cm. bore and 75 cm. long, it is possible to maintain a constant temperature of 1,300° over a length of 7 cm. in the middle of the tube, and the nickel wire can be used for about 150 hours. The repair and renewal of the wire can be easily effected. The fact that nickel wire becomes brittle when heated for a long time at a high temperature is due to the included gas-bubbles, which gradually force their way out, producing laceration of the metal [see Carpenter, Metallurgie, 6. p. 94, Feb. 8, 1909]. T. H. P.

2135. *Manufacture of Silico-Vanadium.* **G. Gin.** (Amer. Electrochem. Soc., Trans. 15. pp. 229–230, 1909. Translation.)—The silicide SiV_2 can be obtained in an electric furnace from vanadic acid, silica, and coke, according to: $3V_2O_5 + SiO_2 + 13C = 2V_2O_2 + SiV_2 + 13CO$. As some V_2O_5 is volatilised, V_2O_3 may advantageously be used. Still easier is the preparation of the double silicide $Fe_4Si_5V_6$ from ferro-silicon, moulded into briquettes or balls with coal-tar pitch, and V_2O_3. H. B.

2136. *Researches on Ferroboron.* **K. Iwai** and **J. C. Ballagh.** (Mining and Scientific Press, Aug. 7, 1909. Metallurgie, 6. pp. 701–703, Nov. 8, 1909. Abstract.)—Ferroboron has been prepared by the direct reduction of iron ore, and colemanite containing 27·43 per cent. B_2O_3, in an indirect arc furnace. The products contained over 1 per cent. carbon and up to 0·75 per cent. boron, according to the amount of steel added in melting. All the samples were hard enough to scratch glass and very brittle, showing a white conchoidal fracture of very fine grain. The microstructure showed pearlite and cementite, and it seemed probable that the boron existed as a ternary eutectic, at all events in the annealed samples. F. C. A. H. L.

2137. *Phosphides of Iron.* **le Chatelier** and **S. Wologdine.** (Comptes Rendus, 149. pp. 709–714, Nov. 2, 1909.)—Four definite phosphides of iron have been isolated by the authors, viz., (1) Fe_3P, having the density 6·74, melting-point 1,110°, magnetic transformation-point 445–435°, and a permeability at ordinary temperatures about one-third that of pure iron; (2) Fe_2P, having the density 6·56, melting-point 1,290°, and magnetic transformation-point 85°; (3) FeP, having the density 5·76, magnetic transformation-point 48°, and 1½ times more magnetic than Fe_2P; and (4) Fe_2P_3, having the density 4·5, and 75 times less magnetic than FeP. No magnetic transformation-point could be found for this. The exact composition of the two last is not so clearly established as is that of the two first. No compounds could be separated corresponding to the formulæ Fe_6P, Fe_4P, Fe_5P_2, Fe_4P_3, or Fe_3P_4. W. H. Si.

2138. *Alloys of Electrolytic Iron with Arsenic and Bismuth.* **C. F. Burgess** and **J. Aston.** (Amer. Electrochem. Soc., Trans. 15. pp. 369–386; Discussion, pp. 386–389, 1909.)—As iron is not readily attacked in acid pickling when arsenic is present, the authors investigated whether alloys of Fe and As were also less corrodible than iron. There was little difference, but some of the (chiefly studied) magnetic and also of the mechanical properties of alloys of Fe with As, Sb, and Bi are remarkable. Some 600 ingots of alloys were prepared in a magnesia crucible heated in an electric furnace; the Swedish iron was electrolytically refined and contained only 0·012 per cent. of carbon, 0·004 P, 0·013 Si, no sulphur nor Mn. The atmosphere consisted of nitrogen and carbon monoxide, and some carbon, perhaps 0·04 per cent., was taken up by the iron from the CO. Iron takes up 4 per cent. of As. Such iron can be forged, but it smells of arsenic; check analyses do not appear to have been made after the heat treatment. The elastic limit of the As-iron was higher than that of the electrolytic iron; the elongation and reduction of area were much smaller. The magnetic tests, conducted with an Esterline instrument, show a marked improvement of the iron by the arsenic; the alloys were heated up to various temperatures, 1,000° C. being the maximum. Of the ingots containing 1, 2, 4, 6, 10 per cent. Sb only the 1 per cent. alloy proved forgeable. The alloys with Bi were of the just-mentioned percentages, but several were spoilt. The 2 per cent. Bi.-alloy gave the highest magnetic density value of any of the ingots, iron and alloys; yet Bi is the most diamagnetic element known. The research is being continued. [See also next Abstract and Abstract No. 2117 (1909).] H. B.

2139. *Physical Characteristics of Iron Alloys.* **C. F. Burgess** and **J. Aston.** (Electrochem. Ind., N.Y. 7. pp. 436–438, Oct., 1909.)—The forging, welding, and machining properties of a variety of alloys of electrolytic iron, with Al, As, Sb, Bi, Cd, Cr, Co, Cu, Ni, Mn, Mo, Se, Si, Sn, V, W, singly or more than one at a time are given. Very little discussion of the results is given, and it is stated that in some instances the work was not sufficiently systematic to allow of definite deductions being drawn. Qualitatively the forgeability of the various alloys corresponds with that of corresponding commercial alloys where such exist. Cr, Mn, Mo, Ni, and W produce self-hardening alloys even in the absence of carbon. Many of these last alloys make satisfactory lathe tools, in the air- or water-hardened condition. [See also preceding Abstract.]
F. R.

2140. *Electrical Conductivity and Flowing Pressure of Isomorphic Mixtures of Lead with Indium and Thallium.* **N. Kurnakow** and **S. Żemcżużny.** (Zeitschr. Anorg. Chem. 64. 2. pp. 149–183, Oct. 8, 1909. Translation from the Ber. d. St. Petersburger Techn. Inst. vol. 11, 1909.)—The conductivity-concentration curve of the lead-indium series is in complete agreement with the thermal data, and shows the continuous curve typical of solid solutions. The curve is very steep at the indium side and has a flat region about the minimum which lies between 50 and 60 atoms per cent. lead. The lead-thallium curve is similar up to about 80 atoms per cent. Pb, the flat minimum occurring at 50 atoms per cent. Pb. At about 20 atoms per cent. Pb there is a discontinuity in the curve marking the limits of the pure β solid solution. The curve rises to a maximum at 95 atoms per cent. Pb, then falls to a minimum at 97 atoms per cent. Pb, and finally rises to the conductivity of Tl. The appearance of the curve indicates, in addition to the α and β phases, the existence of a third intermediate phase—the γ-phase—whose composition lies between 5 and 10 atoms per cent. Pb. The thermal data fail to indicate the existence of this phase, but the above views are confirmed by the temperature-coefficient of resistance curve. A brief review of the work done on hardness and flowing pressure is given, and the authors show by experiment that there is a close parallel between Brinell hardness-numbers and flowing pressure. When measured under definite conditions, the flowing pressure renders important aid in the determination of constitution diagrams. The flowing pressure diagram is just the reverse of the conductivity diagram, and a minimum in the latter becomes a maximum in the former. In the Pb-In series, the flowing pressure-concentration diagram shows a maximum at about 50 atoms per cent. Pb in a continuous curve. The flowing pressure diagram of the Pb-Tl alloys confirms the existence of the γ-phase. Neither the conductivity nor the flowing pressure diagram give any indication of the existence of the compound $PbTl_2$.
F. C. A. H. L.

2141. *New Method for Examination of Mixed Crystals deposited by an Alloy at Various Temperatures.* **D. Mazzotto.** (N. Cimento, 18. pp. 180–196, Sept., 1909.)—The author proposes to determine the composition of mixed crystals deposited from an alloy at any given temperature by a "method of heat of fusion." From the amount of heat developed by the crystals in solidification it is possible to deduce their weight, and, knowing the variation in concentration undergone by the liquid alloy in depositing these crystals, their composition can then be calculated. Examples are given of the application of the method to alloys of Pb and Sn, Sn and Zn, and Zn and Bi.
W. H. Si.

2142. *Corrosion of Steel Winding Ropes.* **M. T. Murray.** (Elect. Engin. 44. pp. 651–652; Discussion, pp. 652–653, Nov. 5, 1909. Abstract of paper read before the Chem. Metallurg. and Mining Soc. of S. Africa.)—Reviews the various theories of rusting, mentions work done by recent investigators, and suggests that the various constituents of iron and steel, such as graphite, ferrite, pearlite, &c., are capable of promoting corrosion by mutual electrolytic action. The author was first led to this belief by an investigation of "double-faggoted" iron, which consists of alternate fibres of wrought iron and mild steel. A sample of this material showed greater corrosion when exposed to damp air than pieces of wrought iron and mild steel of the same composition as that present in the composite bar. Also in the case of fractured case-hardened steels, corrosion proceeded much more rapidly than with a high-carbon hardened steel or a mild steel. The author considers the corrosion of winding ropes in detail, and states that steel cables offer peculiar opportunities for corrosion, owing to the nature of the atmosphere in mine shafts, the structural nature of the cable itself, and also to the continually altering or varying stresses which they have to withstand. In winding ropes the continued friction they are subjected to in passing over the pulleys, &c., keeps them bright, and evidences of corrosion are consequently not easily discovered. C. O. B.

2143. *Liquid Chlorine.* **F. M. G. Johnson** and **D. McIntosh.** (Amer. Chem. Soc., Journ. 31. pp. 1138–1144, Oct., 1909.)—Measurements made on liquid chlorine which had been fractionally distilled three times gave the following results. The vapour pressures, determined by means of the apparatus described by Johnson [Abstract No. 1517 (1908)] are:—

Temperature.	Pressure.	Temperature.	Pressure.	Temperature.	Pressure.
−105·7°	8·0 mm.	−84·3°	39·6 mm.	−47·3°	399·5 mm.
−101·5	9·2 "	−75·3	76·1 "	−39·3	592·0 "
− 96·3	16·5 "	−65·9	141·5 "	−32·0	820·5 "
− 89·8	24·4 "	−56·8	240·6 "		

These results agree well with those obtained by Knietsch [Annalen der Chemie, 259. p. 124 (1890)], who found the boiling-point under atmospheric pressure to be −33·6°, the authors' curve giving −33·7°. At the freezing-point the pressure is 9·2 mm., and the temperature −101·5°. By means of Clausius' formula, $d \log p / dT = W/RT^2$, the heat of vaporisation at 76 mm. pressure for 1 gm.-mol. is calculated to be $21{\cdot}1 \times 10^{10}$ ergs. The density at −78·6° is found to be 1·6720–1·6725, and the density at any temperature, *t*, in deg. Cent. is given by the formula $1{\cdot}725 - 0{\cdot}00248\,(106 + t)$. At the boiling-point, −33·7°, the density is 1·568, and the molecular volume 22·6, which is in good agreement with the value obtained from organic compounds. The ratio of the boiling-point to critical temperature, 0·57, is much lower than the value for the majority of substances, namely, 0·66. The molecular surface energy, $\gamma(MV)^{2/3}$, is a linear function of the temperature, the value being 322·7 ergs at −28·7° and 390·6 at −61·5°; its temperature coefficient is 2·04, so that liquid chlorine has the formula Cl_2. The molecular surface energy is zero at 129·4°, which is 10° to 15° below the critical temperature. No inorganic compound could be found which was ionised in liquid chlorine.

Ether, alcohol, ketones, esters, and other organic compounds containing oxygen dissolve in liquid chlorine, and form compounds which do not conduct. T. H. P.

2144. *So-called Liquid-Crystals and Crystalline Liquids.* **G. V. Vulif [Wulf].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 5. pp. 191–210 (Phys. Part), 1909.)—The author criticises Lehmann's views concerning the nature of liquid-crystals, and attempts to show that anisotropic liquids are two-phase systems. He regards Lehmann's liquid-crystals as consisting of drops of an isotropic liquid, surrounded by colloidal membranes, the double refraction being ascribed to tensions in the colloidal envelopes. As the lines of tension may proceed spirally from one pole to the other, the double refraction may be accompanied by rotation of the plane of polarisation. The liquid streams and other phenomena observed in substances which form liquid-crystals, such as para-azoxyphenetol, in the neighbourhood of the melting-point are explained as follows: The two-phase system of a crystalline liquid resembles a system of two non-miscible liquids, which dissolve partially in one another, and at the critical solution temperature form a single liquid phase. Also, the colloidal flocks of a crystalline liquid are partially soluble in the main bulk of isotropic liquid, and, when the substance becomes clear, are completely dissolved; below the temperature at which this occurs, separation takes place and gives rise to concentration streams (Brownian movements). On further cooling to the solidification-point, crystallisation of the isotropic liquid occurs, the crystals including the colloidal membranes. T. H. P.

2145. *Diffusion of Electrolytes in Aqueous Solution.* **B. L. Vanzetti.** (Accad. Lincei, Atti, 18. pp. 229–234, Oct. 3, 1909.)—Following the method formerly described [Abstract No. 172 (1908)] the author has compared the rates of diffusion of HCl, HBr, and HI, and of their salts of Li, Na, K, Rb, and Cs, experiments being made with solutions having densities ranging from 1·24 to 1·015. In all cases the rate of diffusion increases with dilution, for the free acids approximating more closely to the values calculated from Nernst's formula, but with the haloid salts becoming more divergent from these—a fact which is attributed to hydrolysis of the salts by water. W. H. St.

2146. *New Method for Measuring the Electrolytic Dissociation of Water.* **C. S. Hudson.** (Amer. Chem. Soc., Journ. 31. pp. 1186–1188, Oct., 1909. Contribution from the Bureau of Chemistry, U.S. Dept. of Agriculture, Circular No. 45. Chem. News, 100. p. 213, Oct. 29, 1909.)—The author has shown previously (Ibid. 29. p. 1571, 1907), that the measurements of the velocity coefficient of the mutarotation of glucose in acid, alkaline, or neutral solutions are accurately expressed over the whole range by the formula, $k = A + B(H^{\cdot}) + C(OH')$, where k is the velocity coefficient, A, B, and C are constants, and $H^{\cdot}$ and OH' are the concentrations of hydrogen and hydroxyl ions respectively in the solutions. If, for neutral solutions or pure water, the velocity coefficient be written k_w and the hydrogen-ion concentration, which in this case is equal to the hydroxyl-ion concentration, be written $H^{\cdot}_w$ then $k_w = A + (B + C) H^{\cdot}_w$ or $H^{\cdot}_w = (k_w - A)/(B + C)$. This relation gives a new method for measuring the hydrogen-ion concentration, that is, the electrolytic dissociation of water, for the four quantities on the right-hand side of the equation can be determined experimentally by measuring the rate of mutarotation of glucose in ordinary distilled water and in acid and alkaline solutions. From the author's previous measurements (*loc. cit.*), and from those of Osaka [Abstract No. 676 (1901)] for alkaline solutions, the value of A is found to be 0·0096, B 0·258, and C 9·750, k being expressed in minutes and decimal logarithms, $H^{\cdot}$ and OH' in mols. per litre, and the temperature being 25°. Also, the velocity constant for pure water, k_w, is 0·0106, the value given by Osaka being 0·0104. The substitution of these constants in the formula given above leads to the value $1·9 \times 10^{-7}$ for $H^{\cdot}_w$, which is in close agreement with those obtained in other ways by various investigators. The accuracy of the above method depends primarily on the accuracy with which the difference $k_w - A$ can be measured; for dextrose this difference amounts to only 10 per cent. of the separate quantities, so that the accuracy of the method is probably not greater than about 20 per cent. With lævulose, the difference $k_w - A$ is over 40 per cent. of the separate quantities, so that measurements on lævulose will probably give more accurately a measure of the electrolytic dissociation of water.

T. H. P.

2147. *Constancy of the Hydrogen Gas Electrode.* **C. J. J. Fox.** (Chem. News, 100. p. 161, Oct. 1, 1909. Paper read before the British Assoc. at Winnipeg, 1909.)—The author has investigated the constancy of the hydrogen gas electrode in sulphuric and hydrochloric acids, when Au, Pt, and Pd coated with platinum black or palladium black are employed. Palladium coated with palladium black gives in both 0·1-$n$$H_2SO_4$ and 0·1-nHCl a value 4–5 millivolts too high, this being permanent even when the hydrogen is allowed to pass over the electrode for hours. But Au and Pt coated with either platinum or palladium black give in a very few minutes, in either HCl or H_2SO_4, values concordant among themselves to probably less than 0·05 millivolt; a piece of Au or Pt wire is as good for this purpose as a large piece of foil. It has usually been considered that the hydrogen gas electrode in 0·1-nHCl is not so constant as in 0·1-$n$$H_2SO_4$, but this does not seem to be the case, if precautions are taken against the presence of arsenic, the smallest trace of which would probably "poison" the platinum or palladium black. It seems preferable to use 0·1-nHCl rather than H_2SO_4, because the dissociation constant is so much better known and the ions produced are much simpler. It is not possible to obtain a good coating of platinum black on a very pure specimen of Pt-foil if the platinum chloride solution employed is also very pure; a trace of lead acetate is therefore usually added to the solution, and it is necessary to remove every trace of this from the coated electrode by heating first in oxalic acid solution and afterwards in nitric acid.

T. H. P.

2148. *Conductivity and Ionisation o, Polyionic Salts.* **A. A. Noyes** and **J. Johnston.** (Amer. Chem. Soc., Journ. 31. pp. 987–1010, Sept., 1909. Contribution from the Research Lab. of the Mass. Inst. of Technology, No. 43.)—Measurements are given of the conductivity between 0° and 156° C. of aqueous solutions of KNO_3, $K_2C_2O_4$ (oxalate), $Ca(NO_3)_2$, $K_3C_6H_5O_7$ (citrate), $La(NO_3)_3$, $K_4FeC_6N_6$, $Ca_2FeC_6N_6$, $Ba_2FeC_6N_6$, and $La_2(SO_4)_3$, these salts being selected so as to give a large range of types, uni-univalent, uni-bivalent, uni-trivalent, &c. The important conclusion, previously derived from the study of uni-univalent and uni-bivalent salts, was established that the equivalent conductance, Λ, and the degree of ionisation, γ, of salts vary with the concentration according to approximately the same law, whatever may be the ionic type of the substance or the temperature. This law is expressed in all cases by a function of the form $C(\Lambda_0 - \Lambda) = K(C\Lambda)^n$ or $C(1 - \gamma) = K(C\gamma)^n$, where K and *n* are constants for a definite salt at a definite temperature, and *n* varies with the nature of the salt and with the temperature, but only within very narrow limits, from 1·4 to 1·55, and without reference to the number of ions into which the salt molecule dissociates. The latter point is of great importance, as the simple laws of mass-action would make *n* equal to this number, and therefore varying in the above series of salts from $n = 2$ (for KNO_3) to $n = 5$ (for $K_4FeC_6N_6$ and $La_2(SO_4)_3$). For salts of the same ionic type the coefficient of ionisation is practically independent of the specific nature of the salt, provided that the concentrations and temperature are the same for all. For salts of different ionic types, if the temperature and the concentration of the ions are fixed, then the un-ionised fraction of the salt is roughly proportional to the valences of the ions: it is noteworthy that this proportionality applies to the un-ionised fraction of the salt and not to the *concentration* of the un-ionised part, and that ionic-concentrations in terms of *numbers* of ions are selected and not the usual concentrations in terms of *equivalents;* in the case of salts such as K_2SO_4 the ionic-concentration is that of the ion of higher valence, and is again equal to the *molecular* concentration of the ionised part of the salt. In all cases the ionisation decreases steadily with rising temperature, the decrease being more rapid the higher the temperature and the greater the valence-product of the ions of the salt. The freezing-point lowerings caused by most of the salts were determined and the *i*-factors compared with those deduced from the equation—

$$i = 1 + (n - 1)\,\Lambda/\Lambda_0.$$

Discrepancies considerably exceeding the experimental error and amounting sometimes to 5 to 10 per cent. were found to exist, but no explanation of these could be given. T. M. L.

2149. *Application of the Gibbs-Helmholtz Equation to Concentration Cells.* **F. J. Mellencamp.** (Phys. Rev. 29. pp. 329–350, Oct., 1909.)—For the purpose of testing the Gibbs-Helmholtz equation the author has determined the e.m.f. of several concentration cells, for which the heat of reaction (heat of dilution) is known. The four cells studied were: Cadmium amalgam electrodes with cadmium sulphate of different concentrations; zinc amalgam electrodes and solutions of zinc sulphate; zinc amalgam electrodes and solutions of zinc chloride; lead amalgam electrodes with solutions of lead nitrate. The first two cells have a positive heat of dilution and a positive temperature-coefficient of e.m.f. The third cell has a positive heat of dilution and a negative temperature-coefficient; while the fourth cell has a negative heat of dilution and a positive temperature-coefficient. Calculating the heat of dilution from the values of the e.m.f. and the temperature-coefficients the following values were obtained for the heats of dilution between the concentrations employed: 80, 701, 4,435, and —1,250 Cals., the experimentally determined values (Thomsen) being 82, 722, 4,580, and —1,270 Cals. respectively. The author therefore finds that the Gibbs-Helmholtz equation is applicable to all the cases investigated. A. F.

2150. *Influence of Hydrogen Peroxide on the Properties of Platinum.* **K. Bornemann.** (Zeitschr. Elektrochem. 15. pp. 673–677; Discussion, pp. 677–678, Sept. 15, 1909. Paper read before the 16. Hauptversamml. d.

Deutsch. Bunsen-Gesell., Aachen, May, 1909.)—When freshly ignited platinum is immersed in hydrogen peroxide solution, vigorous evolution of oxygen takes place at first, but this gradually slackens, the catalytic power of the platinum being lost. Similar variation is observed in the electrochemical behaviour of Pt. In H_2O_2 solutions both an oxidation-potential, and a reduction-potential may be assumed. Platinum electrodes which have been rendered inactive by H_2O_2 always show a higher potential than when weakly inactivated. The upper limit for the reduction potential is found to be + 0·69 volt with respect to the hydrogen electrode and calculated for a normal H_2O_2 solution. By kathodic formation of H_2O_2 at Pt electrodes, which is not reversible, the lower limiting value is found to be + 0·64 volt; the reduction potential is hence about + 0·665 volt. Curves showing the relation between decomposition voltage at Pt electrodes and current exhibit for inactivated electrodes a jump at 1·28 volt, which disappears when the electrodes are again rendered active; it is possible that this value corresponds with the reversible oxygen-potential, although no evolution of gas is observed. In explanation of his results the author assumes that pure metallic Pt catalyses H_2O_2 readily, whilst during the decomposition a high platinum oxide—an antozonide—is formed which is catalytically inactive. By treatment with strong oxidising agents or by anodic polarisation, this antozonide is converted into a lower oxide, which is catalytically active but to a less extent than pure Pt. T. H. P.

2151. ***Passivity of Metals.*** **W. J. Müller.** (Zeitschr. Elektrochem. 15. pp. 696–701; Discussion, pp. 701–702, Sept. 15, 1909. Paper read before the 16. Hauptversamml. d. Deutsch. Bunsen-Gesell., Aachen, May, 1909.)—In 0·1-*n* sodium hydroxide solution and with a potential of about — 0·75 volt with respect to the decinormal electrode, thallium goes into solution as a monovalent anode with current densities up to 350 milliamps./cm.^{2}. In *n*-sodium hydroxide, however, and 0·15 amp./cm.^{2} the potential rises to about zero, the current diminishes and the Tl goes into solution as a divalent metal; with further increase of the current the electrode becomes completely covered with brown oxide and evolution of oxygen and ozone occurs. Similar behaviour is observed in dilute sulphuric acid and in sodium sulphate solution. So that in these three solutions a thallium anode exhibits abnormal polarisation phenomena or a passive behaviour, resembling that of a manganese anode in faintly alkaline phosphate solutions [Abstract No. 2305 (1905)]. According to the author's theory [Abstract No. 95 (1905)] the passivity consists of the passage of a metallic modification of low valency into one of higher valency and passivity occurs when the current density reaches a certain value. By saturation of the solution with the metallic salt formed and deposition of this on the electrode, the surface of the latter is diminished and the current density increased. There is hence a connection between passivity and the nature of the anion, passivity occurring the more readily the more sparingly soluble the salt formed. T. H. P.

2152. ***Tungsten as "Valve" Electrode.*** **L. H. Walter.** (Inst. Elect. Engin., Journ. 43. pp. 547–552, Sept., 1909. Elect. Engin. 44. pp. 373–374, Sept. 17, 1909. Electrician, 63. pp. 991–992, Oct. 1, and p. 1018 [*Erratum*], Oct. 8, 1909. Abstract.)—Tungsten behaves, as the author first noticed in experimenting with electrolytic detectors consisting of a lamp filament dipped in sodium chloride, like aluminium and tantalum. Direct-current experiments on the valve effect obtained with a filament from a 50-c.p. osram lamp (contained in an ebonite tube plugged with Wood's alloy) in many electrolytes, well-conducting acids and salts, show that the critical voltages of tungsten are as a rule higher than with Al, but not so high as with Ta. In order to ensure similar conditions comparison cells were built up of Al and Ta wire (anode) and lead (kathode). Heating the cell has little influence on the critical voltage, but increases the leakage current; on the other hand, tungsten cells seem to be very sensitive to cutting off the current, at least in sulphuric acid. Alternating currents are at once rectified, though the tungsten be not previously formed. Still better effects would probably be realised if the metal were available in the drawn condition by alloying it with nickel. H. B.

2153. *Electric Transport and Electrolytic Decomposition of Chloroform.* **F. Bottazzi.** (Accad. Lincei, Atti, 18. pp. 183–185, Sept. 5, 1909.)—When an emulsion of chloroform in water is placed in the middle vessel of an electric transport apparatus and subjected to the action of a current, the chloroform migrates towards the anode, where it undergoes decomposition with formation of hydrochloric acid. T. H. P.

2154. *Electrolytic Decomposition of Hydrochloric Acid.* **F. A. Gooch** and **F. L. Gates.** (Amer. Journ. Sci. 28. pp. 435–446, Nov., 1909. Contribution from the Kent Chem. Lab. of Yale Univ.)—Doumer [see Abstracts Nos. 697, 1011, and 2062 (1908)] has claimed that the ratio of the volumes of oxygen and hydrogen evolved in the electrolysis of hydrochloric acid is constant and independent of the strength of the current and concentration of the solution, and uses his results to show that the velocities of the hydrions and chloridions are equal. In order to test Doumer's results the authors have further studied the electrolysis of hydrochloric acid under various conditions. The apparatus used was on the principle of a Hoffmann voltameter, and was provided with a leveller so that gas measurements could be made directly under atmospheric pressure. In every case the kathode was of Pt, but the material of the anode varied. In the first set of experiments the anodes were of Ag, and their area varied from 1 to 21·4 cm.^{2}; the hydrochloric acid was either *n*/50 or *n*/100, and the current strength varied from 0·05 to 0·085 amp. Oxygen was liberated only when the Ag surface open to attack was small, and in no case attained the proportion (0·382 of the hydrogen) noted by Doumer. As long as the anode exposes a large Ag surface both oxygen and chlorine attack it. Silver chloride once attached may remain fixed upon the anode, but silver oxide is subject to the action of the HCl as well as to that of the liberated Cl; colloidal silver chloride may be formed during these latter reactions. In the next set of experiments the anode was made by dipping a piece of Ag wire—2·27 mm. in diam. and 4 cm. long—in fused silver chloride, and then using it as anode in a preliminary electrolysis of fairly concentrated HCl until chlorine was freely evolved. In the actual experiments the currents used were 0·05, 0·10, and 0·15 amp., and the concentrations of hydrochloric acid were 0·43, 0·86, and 4·3 parts per 1,000. The ratio of oxygen to hydrogen was found to increase markedly as the concentration of the solution decreased, although it was not materially affected by variations in the current strength or in the potential across the electrodes. Doumer's ratio was only attained with the lowest concentration of acid. When the protected Ag anode was replaced by a spiral of Pt wire (area 1·25 cm.^{2}) the ratios of the volumes of oxygen to hydrogen were very little less for the two lower concentrations of acid, but much lower for the higher concentration. In another series of experiments the concentration of the acid was 0·048 parts per 1,000, and the anode (Pt) area 1·25 cm.^{2}; the current varied from 0·07 to 1·0 amp. The ratio of oxygen to hydrogen was fairly constant (= 0·44) throughout the entire period of electrolysis, and higher by about 80 per cent. than Doumer's ratio. Other experiments with Pt anodes of varying area and with acids of different concentrations confirmed the result that the proportion of oxygen liberated increases as the concentration of the solution decreases. The highest ratio (0·477) of oxygen to hydrogen was found at a concentration of 0·0086 parts per 1,000, and at a high current-density (8·12 amps. per dm.^{2}), and is within 5 per cent. of what it would be were water the primary and sole electrolyte. The observed phenomena afford no criterion for deciding how much of the oxygen liberated in the electrolysis of HCl is transferred through the liquid and how much is evolved by the action of transferred Cl at the anode. T. S. P.

2155. *Constitution of the Electric Charge at the Surface of an Electrolyte.* **Gouy.** (Comptes Rendus, 149. pp. 654–657, Oct. 26, 1909.)—The author points out that the general opinion that when an electrolyte is electrified there is an accumulation of ions at the surface, forming an electric screen, leads to contradictions. The charge cannot be entirely a surface charge, the ions being subjected not only to electric forces, tending to accumulate them at the surface, but also to an osmotic pressure, tending to re-establish homogeneity. The author calculates the state of equilibrium, and finds that for large charges, though not for small, almost all the charge is accumulated at the surface, as is generally held. A. F.

REFERENCES.

2156. *Probable Fusion of Carbon in the Electric Arc.* **M. La Rosa.** (N. Cimento, 18. pp. 46–57, July–Aug., 1909.)—The full paper corresponding to Abstract No. 683 (1909).

2157. *Calculations of a Gin Self-circulating Induction Steel Furnace.* **G. Gin.** (Amer. Electrochem. Soc., Trans. 15. pp. 215–228, 1909. Translation.)—Calculations are given for the electrical quantities involved in the design of such a furnace. They appear to be identical with those given in a paper read by the author recently before the Faraday Society. (Faraday Soc., Trans. 5. pp. 146–157, Sept., 1909.)—In the *discussion*, **C. Hering** gives figures for the resistivity and conductivity of fused steel, fused iron, puddle steel, Bessemer steel, and pure copper. W. R. C.

2158. *Influence of Solvents on the Rotation of Optically Active Compounds. XII.* **T. S. Patterson** and **D. P. McDonald.** (Chem. Soc., Journ. 93. pp. 936–945, May, 1908.)—Deals with ethyl tartrate in aromatic halogen derivatives.

2159. *Influence of Solvents on the Rotation of Optically Active Compounds. XIV.* **T. S. Patterson** and **D. P. McDonald.** (Chem. Soc., Journ. 95. pp. 321–327, March, 1909.)—Deals with ethyl tartrate in benzaldehyde and in quinoline.

2160. *Viscosity and Fluidity.* **E. C. Bingham** and **Miss J. P. Harrison.** (Zeitschr. Phys. Chem. 66. 1. pp. 1–32, March 23, 1909. From the English.)

2161. *Solid Hydrates of Ammonia.* **F. F. Rupert.** (Amer. Chem. Soc., Journ. 31. pp. 866–868, Aug., 1909.)